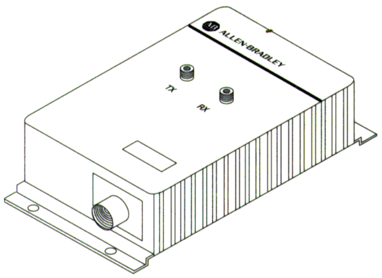
Allen-Bradley

Intelligent Antenna

(Cat. Nos. 2750-AS, -ASD, -ASP, -ASPR, -ASPF, and -ASPRF)



User Manual

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. "Application Considerations for Solid-State Controls" (Publication SGI-1.1) describes some important differences between solid-state equipment and hard wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Allen-Bradley Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Chapter 1 Using This Manual

Chapter Objectives

Read this chapter for an introduction to this manual. This chapter includes:

- Manual Overview
- Intended Audiences
- Related Publications
- Definitions of terms used in this manual

Manual Overview

This manual provides guidelines for using the Allen-Bradley Intelligent Antennas, including these models:

- Catalog Nos. 2750-AS, -ASD, -ASP (Series D or later)
- Catalog No. 2750-ASPR (Series B or later)
- Catalog Nos. 2750-ASPF, -ASPRF

This manual also provides guidelines for using Radio Frequency IDentification (RFID) system components, such as RF tags, RF system host, power supply, and object detect device (optional).

Table 1.A on Page 2 lists and describes the chapters and appendices in this manual.

Manual Chapter Overview

Table 1.A
Manual Chapter Overview

Chapter/ Appendix	Title	Objectives	Intended Audience
1	Using this Manual	Describes the manual contents, defines the intended audience, defines major terms, and lists related publications.	System Application, Programming, Installation
2	Introduction to the RFID System	Describes intelligent antennas, RFID system elements, and typical system operation.	System Application, Programming
3	Host Options and Communication Requirements	Lists options and requirements for selecting and connecting the system host.	System Application
4	RFID Component Setup Guidelines	Describes guidelines for setting up antenna, tags, and object detect device.	System Application
5	Antenna Installation and Connections	Provides instructions for connecting and mounting the antenna.	Installation
6	Using ASCII Commands	Describes format, content, and application of ASCII commands.	Programming
7	Antenna Configuration and Operation	Describes configuring and operating the antenna using the IDP commands.	Programming
8	DF1/PCCC/IDP Communication Protocol	Describes how to develop a host/antenna communication protocol used for operating the antenna and RFID system.	Programming
9	Using IDP Commands	Describes format, content, and application of IDP commands.	Programming
10	Troubleshooting	Describes troubleshooting indications and guidelines.	System Application, Programming
11	RF Tag Hardware and Installation	Describes the RF tag hardware, and provides mounting and handling guidelines.	Installation, System Application
A	Antenna, RF Tag, and Power Supply Specifications	Environmental and operational specifications for the antennas, power supply, and tags.	System Application, Programming, Installation
B	Calculating the BCC	Describes method for calculating the block check character (BCC) used in the DF1 message format.	Programming
C	ASCII Conversion Table	Use to code and decode tag data.	Programming
D	Additional Requirements for Operation in the United States	Lists FCC licensing requirements for antenna operation, ANSI safety standards, and tag disposal guidelines.	System Application, Programming, Installation

Intended Audience(s)

Each chapter in this manual is written for a specific audience, depending on subject matter. Note in Table 1.A, the intended audience is listed for each chapter under "Intended Audience." The audiences listed in Table 1.A are defined and described below:

- **System Application** – person(s) responsible for the application, installation, and set-up of the RFID system. Suggested prerequisites: (1) Skills and experience in implementing automated equipment and systems, and (2) proficiency in consulting equipment specifications and application information, and applying this information.
- **Installation** – person(s) responsible for mounting and connecting the RFID components. Suggested prerequisites: (1) Proficiency in following written procedures and illustrations, and (2) mechanical and/or electrical skills as appropriate.
- **Programming** – person(s) responsible for RFID system programming, and, if necessary, communications protocol. Suggested prerequisites: (1) Proficiency in programming the selected system host, and (2) if applicable, proficiency in implementing communications protocol. This would include experience with protocols described in this manual, and/or with standards listed in ANSI publication X3.28-1976 (D1 and F1 subcategories).

Definition of Major Terms

We use the following terms in this manual as defined below:

- **Antenna** – any Allen-Bradley Catalog Nos. 2750-AS, -ASP, -ASD, -ASPR, -ASPF and -ASPRF Intelligent Antenna.
- **RF tag, or tag** – any of the various Bulletin 2750 RF Tags (radio frequency transponder units).
- **Host** – The RFID system host controller or computer.
- **DF1 protocol** – Allen-Bradley DF1/PCCC/IDP data communication protocol.
- **DF1** – The data link layer of the Allen-Bradley DF1/PCCC/IDP. DF1 combines features of ANSI communication subcategories D1 and F1, as described in ANSI publication X3.28-1976.
- **IDP** – IDentification Protocol. The application layer of the DF1/PCCC/IDP communication protocol.

Related Publications

Table 1.B lists the Allen-Bradley publications referred to in this manual. Consult your local Allen-Bradley sales representative for ordering these publications:

Table 1.B
Related Publications

Publication Number	Title	Content Description
2750-2.23	Product Data, Bulletin 2750 Power Supply (Cat. No. 2750-PA)	Specifications, product data, and installation of the 2750-PA power supply.
2750-2.24	Product Data, Configuring a Radio Frequency Identification System	Typical questions and considerations encountered in designing and installing the RFID system.
2750-2.34	Application Information, Calculated RF System Throughput Time	Method for calculating RFID system throughput, including typical data communication times for various PLC family controllers.
2750-2.35	Application Information, Read Distance Specification Change	Lists the updated read distance specification for RF tags.
2750-2.36	Application Information, RFID Tag Programming Procedures	Discusses programming requirements for the programmable RF tags.
2750-2.37	Application Information, RF Tag Capture Window Calculation	Discusses method for calculating the size of the RFID capture window.
2750-2.9	Product Data, Bulletin 2750 Radio Frequency Tags	Specifications and product data for the various Allen-Bradley RF tags.
2760-810	User Manual, Bulletin 2760 Protocol Interface Chip (Cat. No. 2760-SCA)	Installation and programming of the 2760-SCA chip for communicating with products using DF1 protocol, such as the intelligent antennas in this manual.
2760-812	User Manual,Bulletin 2760 Flexible Interface Module (Cat. No. 2760-RB)	Describes the installation and programming of the 2760-RB module
2760-823	User Manual, Bulletin 2760 DF1/ASCII Protocol Cartridge (Cat. No. 2760-SFC1)	Describes the installation of the 2760-protocol cartridge and use of the cartridge with the Flexible Interface Module for communicating with products using DF1 or ASCII protocol, such as the intelligent antennas described in this manual.

Chapter 2 Introduction to the RFID System

Chapter Objectives

This chapter describes the 2750-AS series Intelligent Antenna and other required RFID system components, and gives an overview of RFID system operations.

Description of the Intelligent Antenna

The Allen-Bradley 2750-AS series Intelligent Antenna transfers information between an RF tag and a host computer or programmable controller.

The antennas interface directly with the host through either RS-232 or RS-422 communications cable. The host must use one of two user-selectable communication protocols.

The antennas communicate with RF tags through a bi-directional RF link.

There are six models of 2750-AS series antenna. The different models are briefly described in the following information:

Catalog No. 2750-AS Intelligent Antenna – Performs either read or write transactions with read/write tags, or read only transactions with programmable tags. The operating range is up to 4 feet (122 cm) for programmable tags, and up to 2 feet (61 cm) for read/write tags. Electronics and antennas are integrated in one unit.

Catalog No. 2750-ASD Short Range Antenna – Performs the same transactions as 2750-AS. Antenna signal is transmitted through connectable remote antenna head. Operating range is up to 8 inches (20 cm) for read/write or programmable tags.

Catalog No. 2750-ASP Programming Antenna – Performs the same transactions as 2750-AS, but also programs the programmable tags. For programmable tags, the read range is up to 4 feet (122 cm) and the programming range is 5-7 inches (13-18 cm). Operating range for read/write tags is up to two feet (61 cm).

Catalog No. 2750-ASPR Remote Programming Antenna – Performs the same transactions as 2750-ASP. Antenna signal is transmitted through connectable remote antenna head. For programmable tags, the read range is up to 5 feet (152 cm); the programming range is 5-9 inches (13-18 cm). Operating range for read/write tags is up to 4 feet (122 cm).

Catalog No. 2750-ASPF High Speed Intelligent Antenna – Performs the same transactions as 2750-ASP but it can decode 2750-TAU40, Series B Programmable tags traveling at high speeds. The 2750-ASPF will allow decoding of a 6 digit format tag at speeds up to 100 mph (8800 feet per minute). Electronics and antennas are integrated in one unit.

Catalog No. 2750-ASPRF High Speed Intelligent Antenna – Performs the same transactions as 2750-ASPR but it can decode 2750-TAU40, Series B Programmable tags traveling at high speeds. The 2750-ASPRF will allow decoding of a 6 digit format tag at speeds up to 100 mph (8800 feet per minute).

Hardware Features

The six antenna models all have these features:

- LED panel for diagnostic indications.
- Flanged back plate with mounting holes.
- Removable cover plate with access opening for antenna wiring connections.
- Terminals for connecting RS-232 or RS-422 communication lines, the power supply, and the object detect device

In addition, the 2750-ASD, -ASPR, and -ASPRF models feature:

- RX and TX connectors on the antenna body for connecting cables to the remote antenna head.
- Remote antenna head with RX and TX connectors.
- Two 10 foot (3.05 m) coaxial cables for connecting antenna body to remote head (Catalog No. 2750-H1).

Figure 2.1 shows the 2750-AS Intelligent Antenna (2750-ASP and -ASPF antennas are identical in appearance).

Figure 2.2 shows the 2750-ASD model with remote head (2750-ASPR and -ASPRF are identical in appearance).

Description of the Intelligent Antenna
(continued)

Figure 2.1
2750-AS -ASP and -ASPF Intelligent Antenna

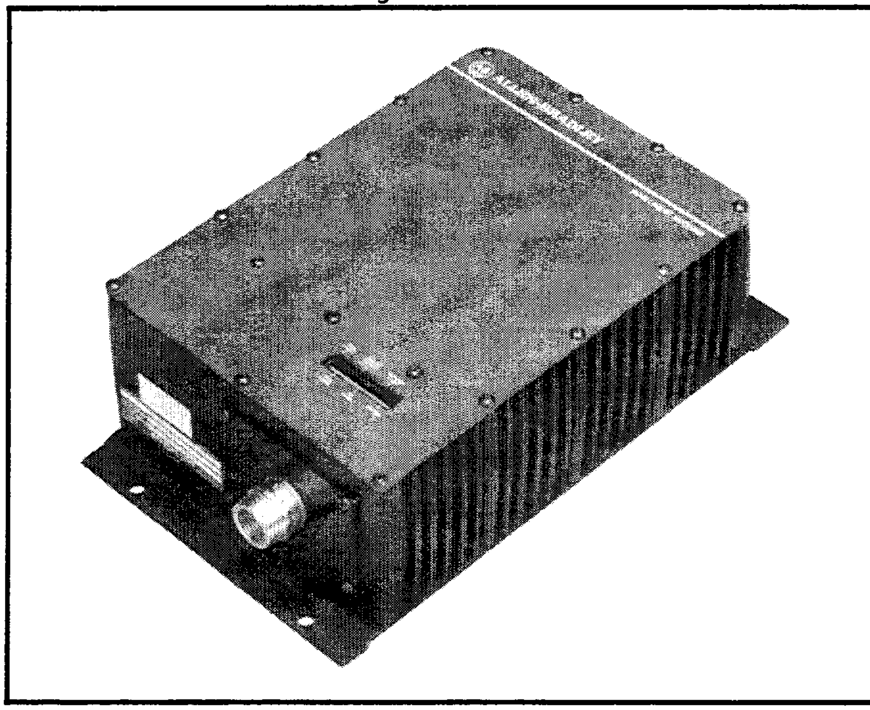

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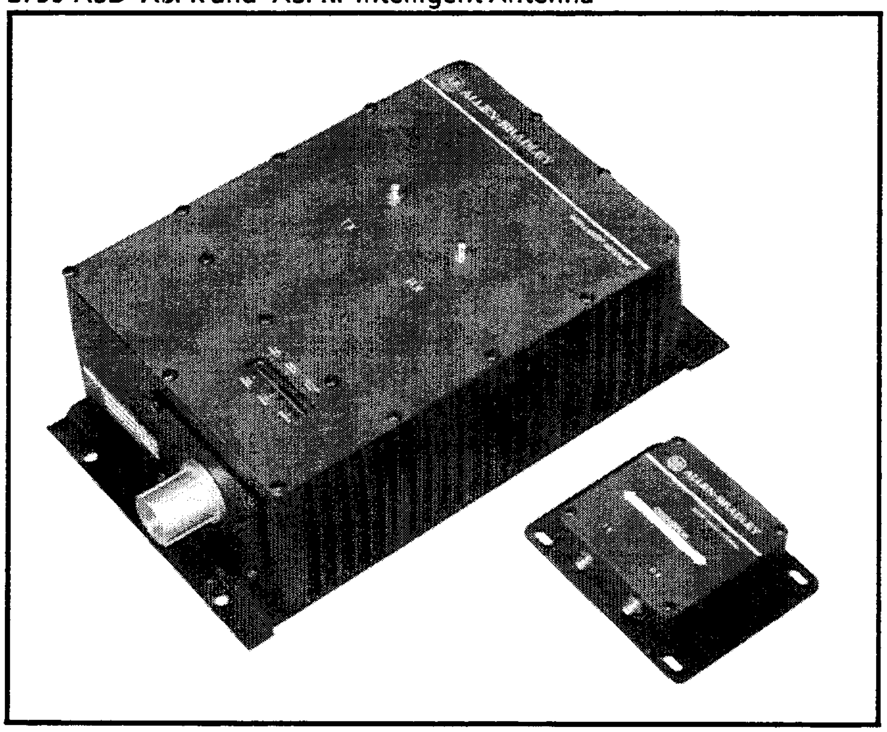
Figure 2.2
2750-ASD -ASPR and -ASPRF Intelligent Antenna



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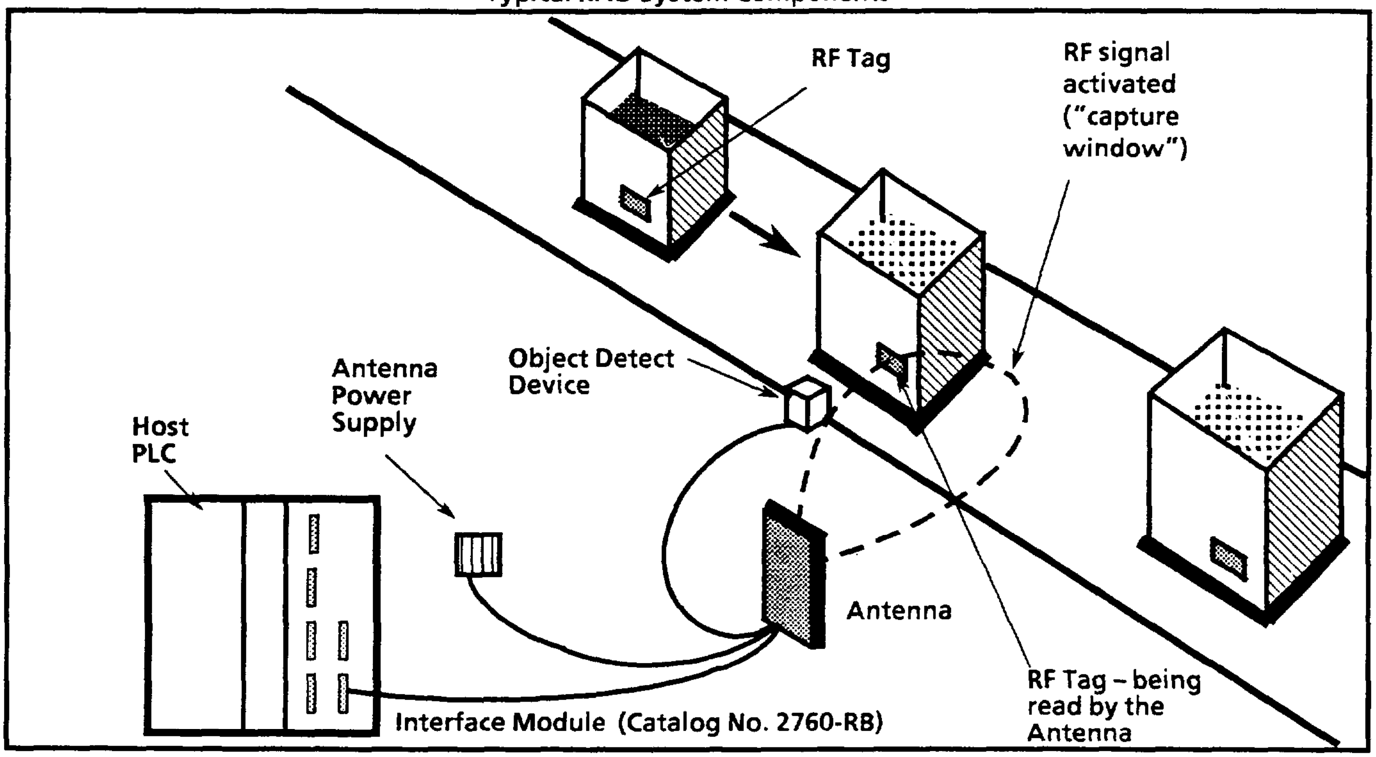
RFID System Components

The Allen-Bradley 2750-AS series antenna is one of several components required for RFID system operation. Other required components are (see Figure 2.3):

- RF tags
- Host PLC or computer
- Object detect device (optional)
- Power Supply

Figure 2.3
Typical RFID System Components



RF Tags

RF tags are attached to objects for automatic identification and/or information transfer. Each tag has internal memory for data storage. There are two basic types of RF tags as described below:

Read/Write Tags – Up to 2K or 8K bytes of data can be stored in a read/write tag (depending on model). Data can be read from a tag or written to a tag during on-line operations. Tags have byte-addressable, battery-backed RAM memory.

Programmable Tags – Tags can operate as having 6-digit, or 20- or 40-character memory (depending on antenna configuration). Tags have non-volatile, EEPROM memory, and are normally programmed off-line. Data is read from tags during on-line operations.

RFID System Host

The Allen-Bradley 2750-AS series antenna is designed to be interactive with a host PLC or computer. The host device sends commands to the antenna through a serial data link.

Power Supply

The antenna requires an external 24VAC power supply. The Catalog No. 2750-PA Power Supply is recommended.

Object Detect Device

The antenna has terminals for connecting the output from an external object detect (presence sensing) device. The object detect contact closure signals the antenna to begin attempting communication with the tag.

Use object detect to enable the antenna to transmit only when the targeted tag is present. Using object detect can reduce antenna signal on-time, which decreases the chance of signal interference between antennas, or the unintended reading of a non-targeted tag.

Any of a number of devices can be used as the object detect. The antenna can serve as a power supply to certain object detect device types. Allen-Bradley Bulletin 880L devices are recommended.

Antenna Operation

You operate the antenna by sending appropriate commands to the antenna from the host. The antenna returns a response to each command except a *Reset*. The antenna response includes a success/fail code, and any data requested in the command. The antenna commands are used to:

- Configure the antenna for tag type, object detect, transaction timeout, and RF field strength level.
- Configure the antenna for host communication.
- Return the current settings of the above parameters.
- Reset the antenna to default communication parameters.
- Run antenna diagnostics and return diagnostic results.
- Perform tag transactions.

Tag Transactions

There are three types of tag transactions:

Read Tag – The antenna reads data from a tag and transfers the data to the host. This type of transaction is valid for either a read/write tag or programmable tag.

Write Tag – The antenna transmits the data to a tag; the data is stored tag RAM memory. This transaction is valid only for a read/write tag.

Program Tag – The antenna transmits data to a tag; the data is stored in tag's EEPROM. This transaction is valid only for a programmable tag.

The tag transactions can be performed with varying options:

Repeat Count – automatically repeats a transaction a specified or an unlimited number of times, or performs the command once.

Chained Commands – combines multiple transactions in a single command, such as a read tag transaction followed by a write tag transaction.

Addressable Tag Memory – specifies the tag memory locations accessed in read or write transactions.

Note: For read/write tags, which have 2K or 8K bytes of memory, the amount of data transferred per transaction is limited, depending on the protocol you use.

Object Detect – attempts the tag transaction only when the object detect signal goes active.

Timeout – limits the duration of the transaction. Specifying a timeout limit, based on the requirements of your application, is recommended.

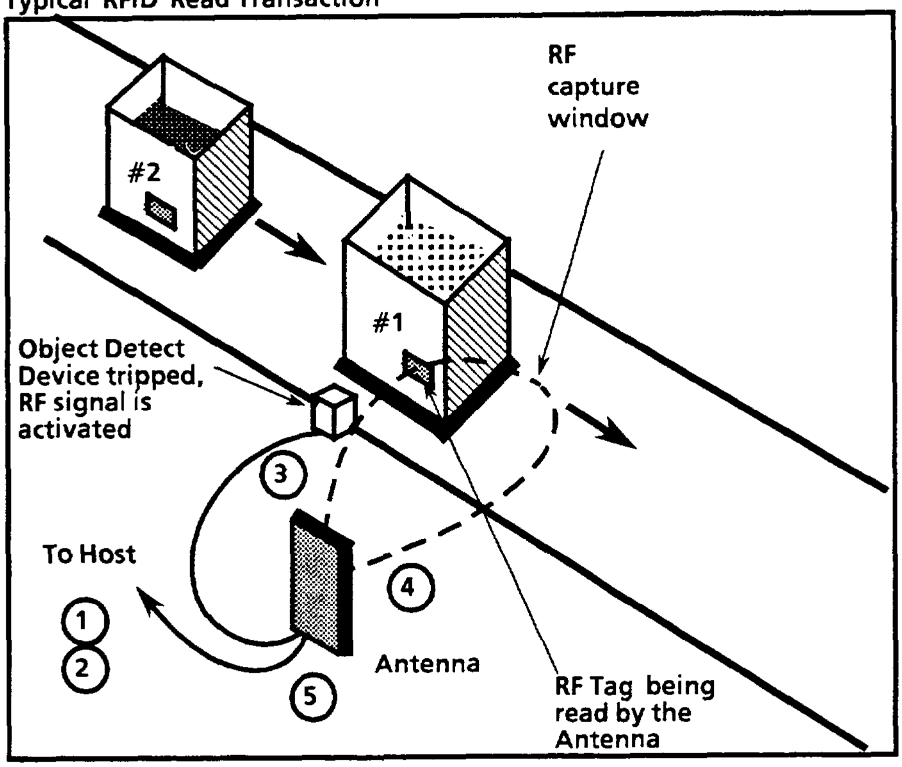
Typical "Read" Application

This section describes a typical read tag transaction. Refer to Figure 2.4:

Programmable tags are mounted on pallets, which move along a conveyor. The tags each contain a 40-character code identifying the pallet.

An object detect device (photoelectric switch) is connected to the antenna. The device is placed near the edge of the antenna signal operating range (RF capture window) so communication begins when the tag is within range.

Figure 2.4
Typical RFID Read Transaction



Sequence of Operation - The following events occur in the scenario in Figure 2.4 for a read tag transaction:

1. At system startup, the host sends a configuration command to the antenna. This sets the antenna tag type (read only), RF power level (low), object detect input (enabled), and timeout limit for tag communication (3 seconds).

2. The host sends a command to the antenna to read the 40-character code from the tag. The antenna then waits for the object detect to go active.

3. Pallet #1 trips the object detect.

Typical "Read" Application
(continued)

4. The object detect active signal enables the antenna to start transmitting, reading the tag. The RF tag on pallet #1 moves into the antenna's RF signal (called the *capture window*). The antenna attempts to read the tag until successful, or until the 3-second timeout expires.

   Note: The capture window is discussed in Chapter 4.

5. Upon a successful tag read, the antenna returns a response to the host, which includes the 40-character code from the tag.

   If the read fails, the antenna returns a response with a code indicating the type of failure.

Steps 2-5 are repeated for pallet #2, and for as long as the system is running.

RFID Site Evaluation

Because of the nature of the RF signal, certain physical site factors may require adjustment in order to enhance the reliability of your RFID system operation.

You can contract Allen-Bradley Support Division to conduct a site evaluation. The site evaluation will determine what site accommodations are required.

General guidelines for component set-up can be found in Chapter 4, *RFID Component Setup Guidelines*.

Chapter 3 Host Options and Communication Requirements

Chapter Objectives

This chapter describes the types of host and communication protocols you can use to operate the Allen-Bradley 2750-AS series antenna. This chapter discusses:

- Programmable controllers (PLC controllers), interface modules, and computers that can be used as system host.
- Communication protocols that can be used to communicate with the antenna.
- Communication parameters which need to be set.

Host Options

Use either a computer or a PLC as the system host.

PLC Controller Options – Use any of the Allen-Bradley PLC controllers (PLC-2, PLC-3, or PLC-5) as system host. With a PLC controller, you must also use one of the following interface modules:

- Catalog No. 2760-RB Flexible Interface Module, with Catalog No. 2760-SFC1 DF1/ASCII Protocol Cartridge, for either DF1 or ASCII protocol communication.
- Catalog No. 1771-DB BASIC Module – with Intelligent Sensor Interface Chip (Catalog No. 2760-SCA) for DF1 protocol communication.
- Catalog No. 1771-DA ASCII Module for use with ASCII protocol.
- Catalog No. 1771-KE (KF) Data Highway Module for use with DF1 protocol.

Computer Options – Use a computer with the capability of supporting RF system programming and serial communication such as:

- Allen-Bradley Catalog No. 6121 Industrial Support Computer
- Allen-Bradley Catalog No. 1784-T47 Laptop Industrial Support Computer
- Allen-Bradley Catalog No. 1784-T50 Industrial Terminal
- IBM-AT or compatible computer

Note: You can also connect a computer to the Allen-Bradley Catalog No. 2760-RB module, and use the 2760-RB to interface with the antenna as described above under "PLC Controller Options."

Host Communication Protocols

To communicate with and operate the antenna, you can use either of two communication protocols, ASCII or DF1.

ASCII Protocol

ASCII protocol is useful for equipment set-up and operation checks. Using ASCII protocol, you can issue antenna commands by transmitting a single ASCII character, in some cases.

Note: The ASCII protocol is not intended as a substitute for DF1 protocol. ASCII protocol data security is only as good as the quality of the data link. This is not recommended for use in an environment which produces electrical noise.

To use ASCII protocol, refer to the ASCII commands described in Chapter 6.

DF1 Protocol

DF1/PCCC/IDP, or DF1 protocol, is designed for operation in environments which can induce noise on the communication lines. Since many industrial applications involve a noisy environment, we highly recommend the use of this protocol.

DF1 protocol includes a character block check function, retries, message acknowledgement, duplicate message checking, and other security functions to help assure the integrity of communications.

For PLC users, interface modules which supply the DF1 protocol are recommended (see page 3-1). If you use a computer as host, you must develop your own programming for DF1 protocol (described in Chapter 8), or use the Catalog No. 2760-RB module.

For DF1 protocol operation, refer to the antenna IDP commands described in Chapter 9.

Hardware Interface to Antenna

You can connect either RS-232 or RS-422 lines to the antenna. Refer to the host's User's Manual and interface module User's Manual (if used) for specific cable pinout information.

Communication Interface Parameters

These communication parameters on the host side of the communication link must match the antenna settings:

- 8 bits/character
- No parity
- One stop bit

Hardware-Configurable Parameters

These communication parameters are configurable when you remove the antenna wiring cover plate:

- Power-up Default Baud Rate – dial selectable, 300-19200 baud (see pages 5-7 and 5-8). Factory setting is 9600 baud.
- Transmission mode – jumper selectable (for DF1 protocol only – see "Transmission Modes," page 9-3). See pages 5-7 and 5-8 for jumper setting information.

Programmable Interface Parameters

When using DF1 protocol, some antenna interface parameters can be changed through a "Set Interface Configuration" command (see page 9-15).

Upon Reset or power-up, the antenna reverts to using the default communication settings.

Chapter 4 RFID Component Setup Guidelines

Chapter Objectives

This chapter presents guidelines to apply when installing RFID components – antenna, RF tags, and object detect device. Read both this chapter and Chapter 11 **before physically installing the antenna, RF tags, and object detect device.**

Note: Some of the procedures in this chapter require that you use the Allen-Bradley Field Strength Meter (Catalog No. 2750-DS).

Component Set-up Overview

In order to enhance the reliability of tag communication, you must set up the RFID system components so that the targeted RF tag, and only the targeted tag, is within the capture window when the tag transaction is attempted.

To accomplish this, you need to complete the steps listed below, which are discussed in following sections:

- Determine the component spacing for the intended RFID operation (i.e., antenna-to-tag spacing and tag-to-tag spacing).
- Set the RF field strength level of the antenna signal, and determine the limits of the signal capture window (use of the Field Strength Meter is required).
- Correctly orient the tags to the antenna.
- Position the object detect device (if used).

Note: The dimensions and ranges discussed in this chapter are offered as general guidelines only. Actual setup dimensions may differ, depending on site specific factors.

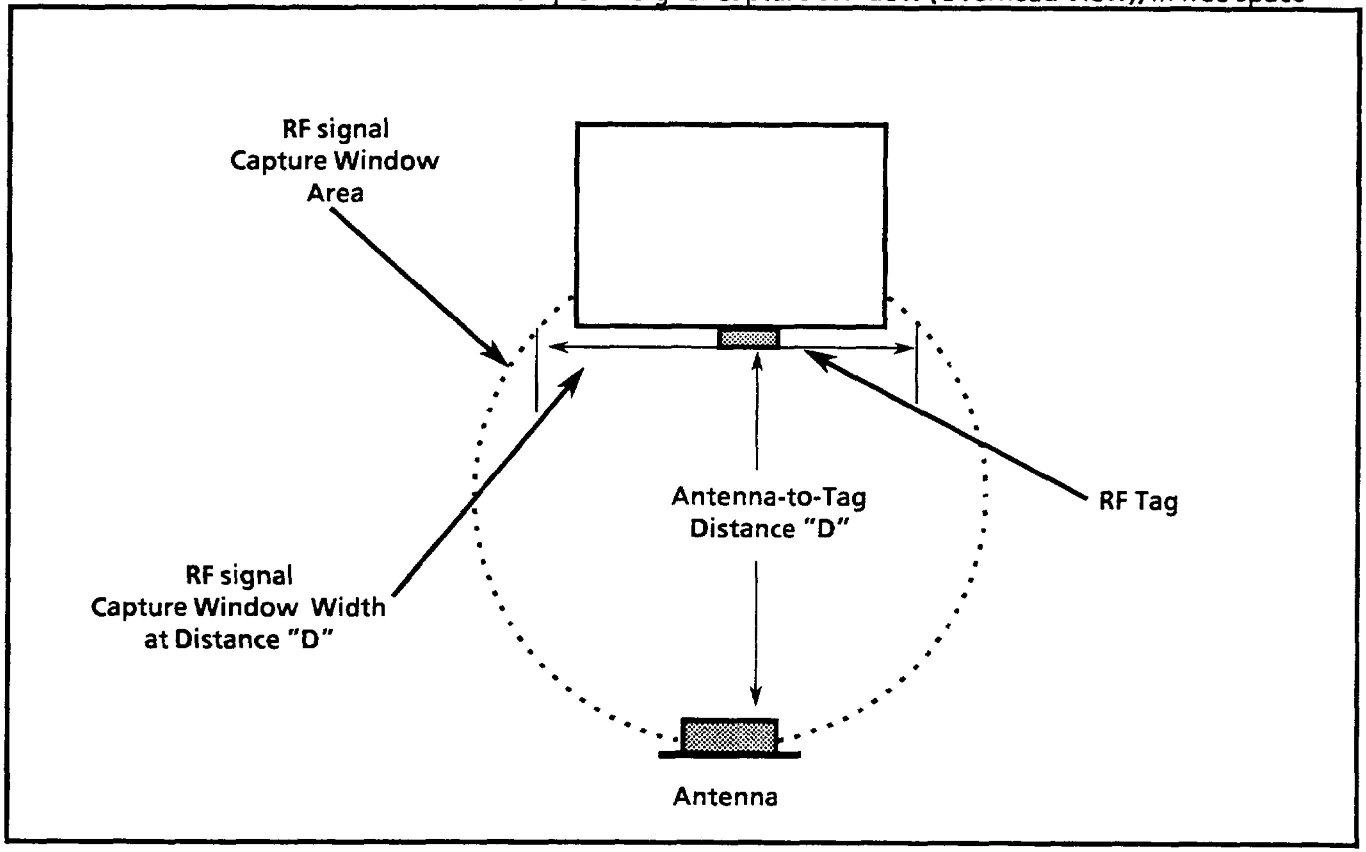
Capture Window

The **capture window** is the area within the antenna's RF field where the field strength is adequate for consistent tag communications (see Figure 4.1). This operating range varies, depending on the antenna type, tag type, the RF level setting, and the type of operation (see Table 4.A).

The antenna can also communicate with a tag outside this range, but communication is less reliable. Because of this, certain minimum spacing requirements must be maintained (see "Antenna-to-Tag Spacing" and "Tag-to-Tag Spacing").

Capture Window
(continued)

Figure 4.1
Example RF Signal Capture Window (Overhead View), in free space



Antenna-to-Tag Spacing

Antenna-to-tag spacing is the perpendicular distance from the antenna face to a tag positioned directly in front of the antenna for a transaction (see Figure 4.1). Table 4.A lists the nominal operating ranges (under "Antenna-to-tag Spacing") for the different antennas, tag types, and operation types.

Antenna-to-tag spacing will influence the tag-to-tag spacing requirement (see "Tag-to-tag Spacing"). Generally, the greater the antenna-to-tag distance, the higher the required antenna RF power level; at higher power levels, more tag-to-tag spacing is required to isolate the non-targeted tags from the RF signal.

Antenna-to-Tag Spacing
(continued)

Table 4.A
Antenna-to-Tag Spacing Ranges

Tag Type	Transaction	Antenna Type	RF Level Settings	Antenna-to-Tag Spacing
Read/Write①	Read or Write	2750-AS, -ASP, -ASPF	5 levels	6 to 24 inches (15.2 to 61 cm)
		2750-ASPR, -ASPRF	5 levels	6 to 48 inches (15.2 to 122 cm)
		2750-ASD	2 levels	2 to 8 inches (5.1 to 20 cm)
Programmable ①	Read	2750-AS, -ASP, -ASPF	5 levels	6 to 48 inches (15.2 to 122 cm)
		2750-ASPR, -ASPRF	5 levels	6 to 60 inches (15.2 to 152 cm)
		2750-ASD	2 levels	2 to 8 inches (5.1 to 20 cm)
	Program	2750-ASP	1 level②	5 to 7 inches (12.7 to 17.8 cm)
		2750-ASPR, -ASPRF	1 level②	5 to 9 inches (12.7 to 23 cm)

① See Publication No. 2750-2.9, Product Data, "Bulletin 2750 RF Tags," for more information relating to tag operating characteristics.
② When programming programmable tags, the antenna transmits at a fixed power level.

Tag-to-Tag Spacing

A minimum spacing is required between the RF tags at the point where tags cross the antenna signal for transactions, in order to help prevent reading from or writing to a non-targeted tag. This also helps prevent unnecessary tag battery drain when using read/write tags.

This section assumes your tag-to-tag spacing is adjustable. If your tag-to-tag spacing is fixed, you may have to adjust the the antenna-to-tag spacing to accomplish the required isolation.

Note: If you require tighter tag-to-tag spacing than suggested in this section, call your Allen-Bradley representative for application assistance.

Programmable Tag Spacing

Read Operations-Normal – In general, the tag-to-tag spacing should be at least three times antenna-to-tag spacing (see Figure 4.2) to isolate non-targeted tags from the RF signal.

Note: For Catalog No. 2750-ASD antennas, tag-to-tag spacing minimums are 38 inches (96.5 cm) for high power settings, 32 inches (81.3 cm) for low power settings.

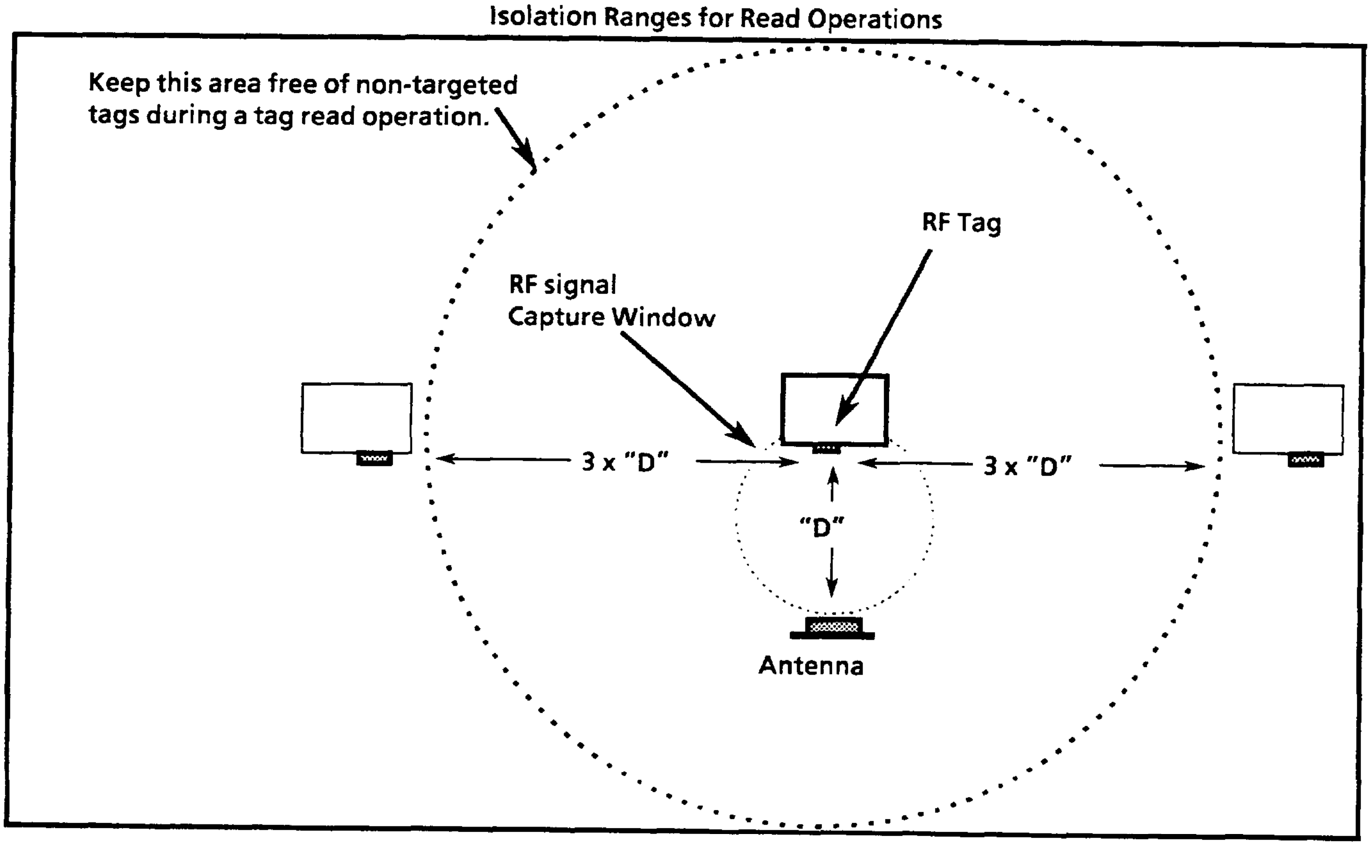
Example Spacing Calculation – Assume the antenna-to-tag spacing is 20 inches (51 cm). The minimum tag-to-tag spacing would be (3×20) inches, or 60 inches (152 cm).

Read Operations-High Speed (2750-ASPF and -ASPRF Antennas Only) – These antennas require an additional 3 feet (1 meter) of tag-to-tag spacing for each for each 10 miles (16.1 km) per hour of tag speed.

Example Spacing Calculation for High Speed Operation – Assume the antenna-to-tag spacing is 20 inches (51 cm) and tag speed is 20 miles (32.2 km.) per hour. The minimum tag-to-tag spacing would be (3×20) inches plus 6 feet, or 11 feet (3.35 m).

Programming Operations - All Antennas – Non-targeted tags must be kept outside a clear zone as shown in Figure 4.3, page 4-5, where distance $X = 20$ feet (61 m).

Figure 4.2
Isolation Ranges for Read Operations



Read / Write Tag Spacing

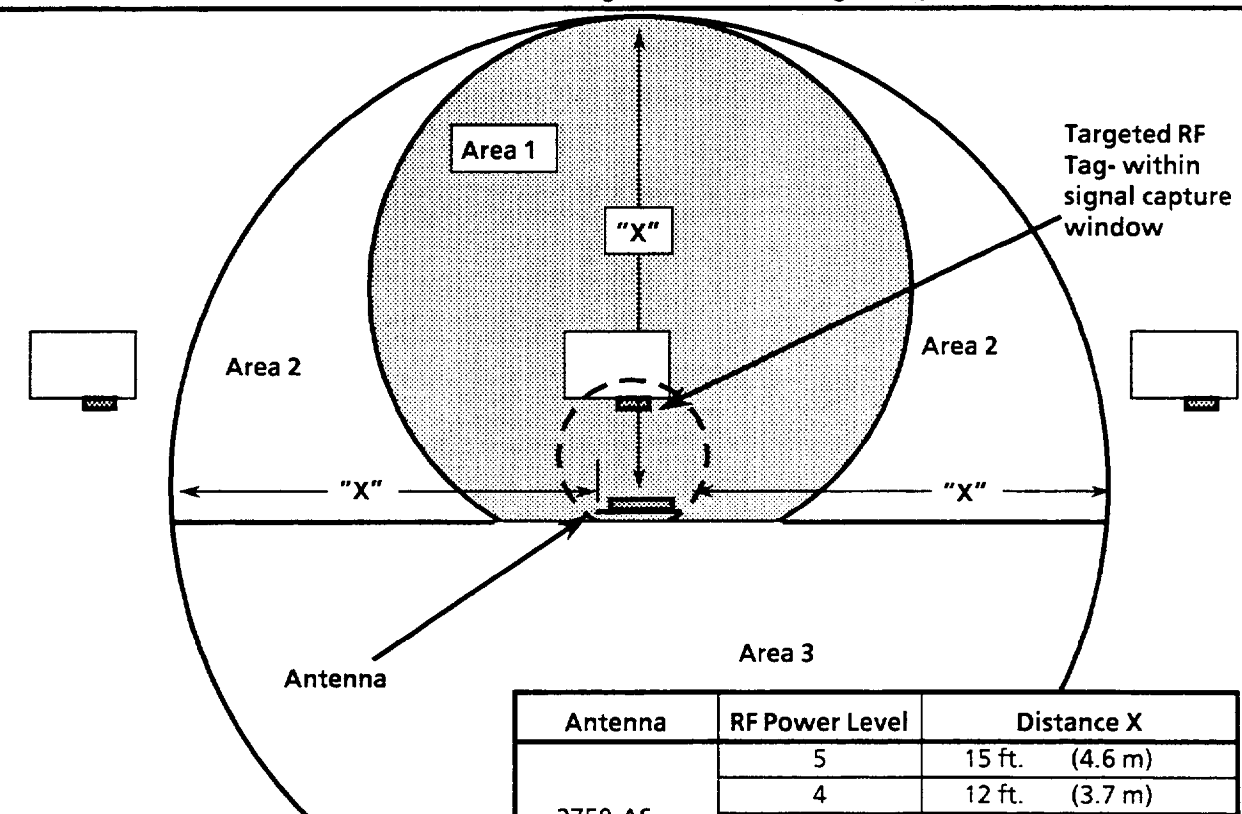
Read Operations-Normal – In general, the tag-to-tag spacing should be at least three times antenna-to-tag spacing (see Figure 4.2) to isolate non-targeted tags from the RF signal.

***Note:** For Catalog No. 2750-ASD antennas, tag-to-tag spacing minimums are 38 inches (96.5 cm) for high power settings, 32 inches (81.3 cm) for low power settings.

For Catalog Nos. 2750-ASPF and -ASPRF tag separation of 3 feet (0.9 m) and 10 mph speed is recommended.

Write Operations-All – Set tag-to-tag spacing according to the distances as shown in Figure 4.3. Distance *X* depends on the power level setting, as shown in Figure 4.3.

Figure 4.3
Isolation Ranges for Write or Program Operations



Area 1- Minimum recommended spacing range. No tags other than targeted tag in this range during transmission.

Area 2- Preferred spacing range for additional tag isolation. No tags other than targeted tag in this range during transmission.

Area 3- Preferred spacing range behind the antenna(tags in this area may be subject to reflected signals).

Antenna	RF Power Level	Distance X
2750-AS 2750-ASP 2750-ASPF	5	15 ft. (4.6 m)
	4	12 ft. (3.7 m)
	3	9 ft. (2.7 m)
	2	6 ft. (1.8 m)
	1	3 ft. (0.9 m)
	Idle①	6 in. (15 cm)
2750-ASPR 2750-ASPRF	5	32 ft. (9.8 m)
	4	23 ft. (7.0 m)
	3	18 ft. (5.5 m)
	2	12 ft. (3.7 m)
	1	8 ft. (2.4 m)
	Idle①	8 in. (20 c m)
2750-ASD	Low or High	4 ft. (1.2 m)
	Idle①	2 in. (5 cm)

① Idle: Weak signal emitted when antenna is powered up, but not attempting to transmit.

Positioning the Antenna

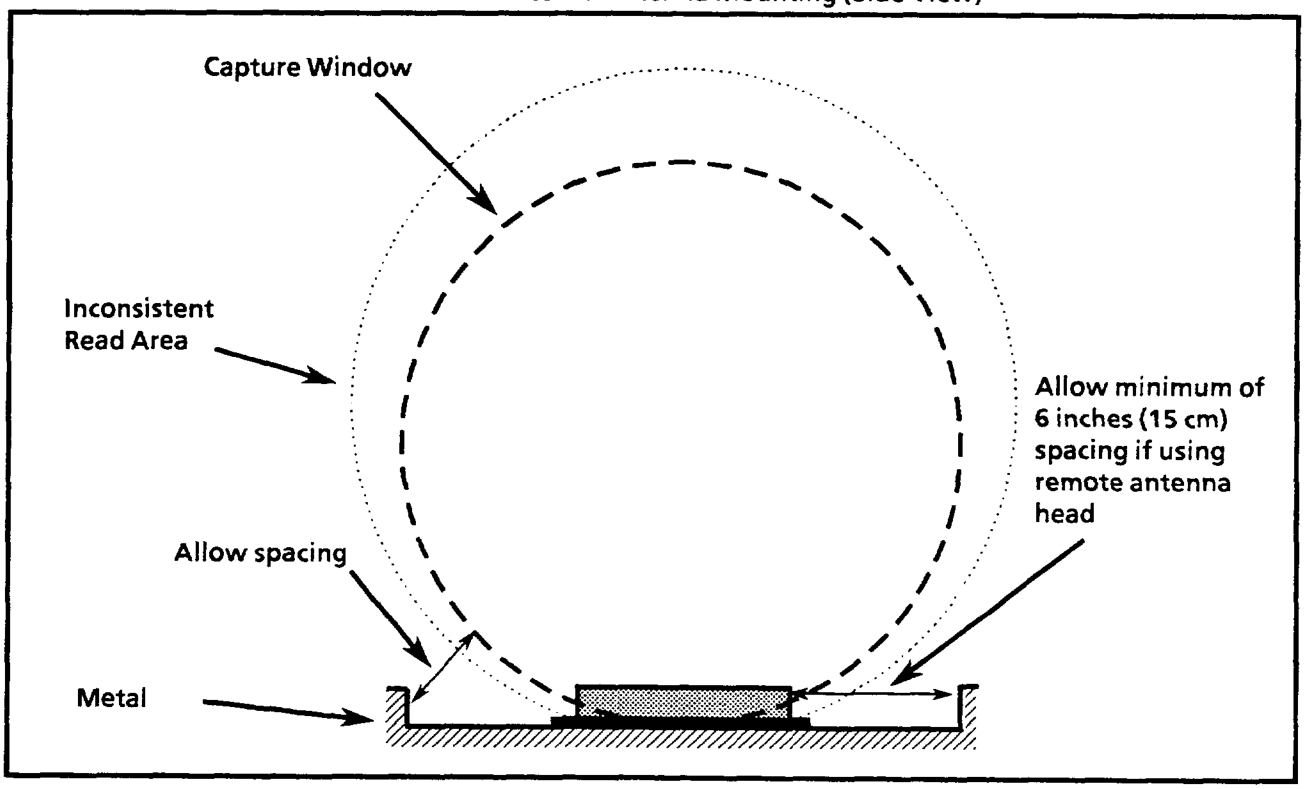
When positioning and mounting your antenna, follow the guidelines offered in this section.

Recessed Mounting

If you plan to mount the antenna within a recessed metal cavity, call your Allen-Bradley representative for application-specific guidelines. General guidelines are:

- Allow spacing between the capture window boundaries and the metal walls (refer to Figure 4.4).
- For remote antenna heads (Catalog No. 2750-H1), allow a 6-inch minimum spacing between metal surface and sides of antenna.
- Position the antenna at the top of the recess.

Figure 4.4
Recessed Antenna Mounting (Side View)



Effects of Metallic Surfaces

Surrounding metallic surfaces (which cause reflections) may create signal peaks and nulls in your capture window. Nulls can inhibit tag transactions.

Minimizing the Effect of Metallic Surfaces

If possible, keep the areas between and to the sides of the antennas and tags free of metallic surfaces (see Table 4.B for metallic surface distances for stationary transactions).

Table 4.B
Minimum Spacing from Antennas to Nearby Metallic Surfaces

Distance Between Tag and Antenna	Minimum Distance Between Tag and Reflective Surface
Up to 3 inches (76mm)	10 inches (254mm)
Over 3 inches (76mm)	Three times (3 X) the tag to antenna distance

If you can not follow the spacing recommended in Table 4.B, minimize the effect of surrounding metal as follows:

- Set up the RF operation so tags are moving through the capture window during antenna communication, so the tags move through any nulls.
- For stationary transactions, locate a position where the RF signal level is adequate for your tag type. To do this, use the Allen-Bradley 2750-DS Field Strength Meter (see page 4-8).

  The locations of peaks and nulls should not change, as long as the locations of surrounding metallic surfaces do not change. If locations of metal surfaces are changed, you may have to adjust the stop location or shift the antenna location as required.

Before permanently positioning the antenna and/or tags, use the Allen-Bradley 2750-DS Field Strength Meter to check the RF field strength throughout the area intended for tag operations (see page 4-8).

Although use of the Field Strength Meter is recommended, the following formulas can be used to determine possible locations of peaks and nulls (refer to Figure 4.5):

Minimizing the Effects of Metal Surfaces (continued)

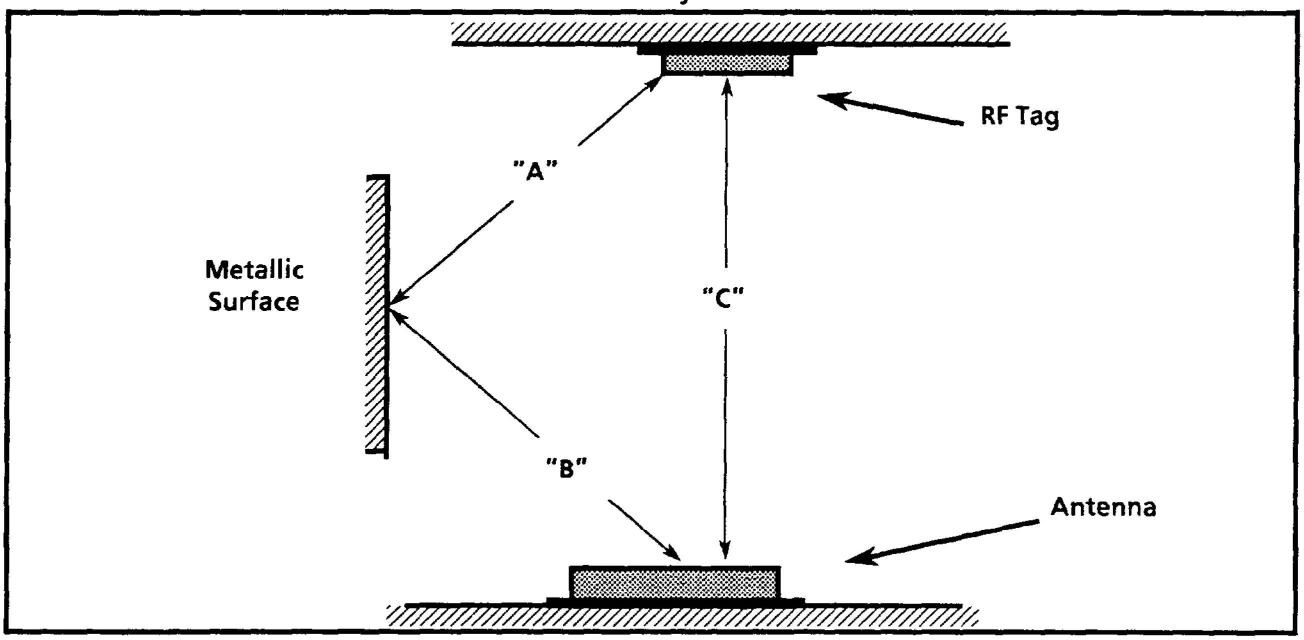
Peak – Signal enhancement (this can cause tag reads outside the capture window) at these distances:

$(A + B) - C = (n)\,\lambda,\ \pm 15\%$
where n is a whole number, $\lambda = 13$ inches (33 cm).

Null – Signal cancellation can occur at these distances:

$(A + B) - C = (n/2)\,\lambda,\ \pm 15\%$
where n is an odd whole number, $\lambda = 13$ inches (33 cm).

Figure 4.5
Effects of Nearby Metallic surfaces



Defining the Capture Window Boundaries

We recommend you measure the antenna field strength to define the capture window boundaries, and thus determine the area of operation. After positioning the antenna for your application, set and adjust the antenna field strength level, using the Allen-Bradley Field Strength Meter, Catalog No. 2750-DS. The required field strength level depends on the tag type.* See the "Field Strength Meter Instruction Sheet" (Part No. 40062-108-01) for instructions.

* **Note:** Tag sensitivity decreases if tags are not mounted on a metal backplane (except for Flatpak-type tags, which are designed for non-metal mounting surfaces). See Chapter 11 for guidelines and recommendations for installing the different RF tags.

Tag-to-Antenna Orientation

When the antenna attempts to communicate with a tag, the tag must be properly oriented to the antenna, or communication can be hindered or prevented.

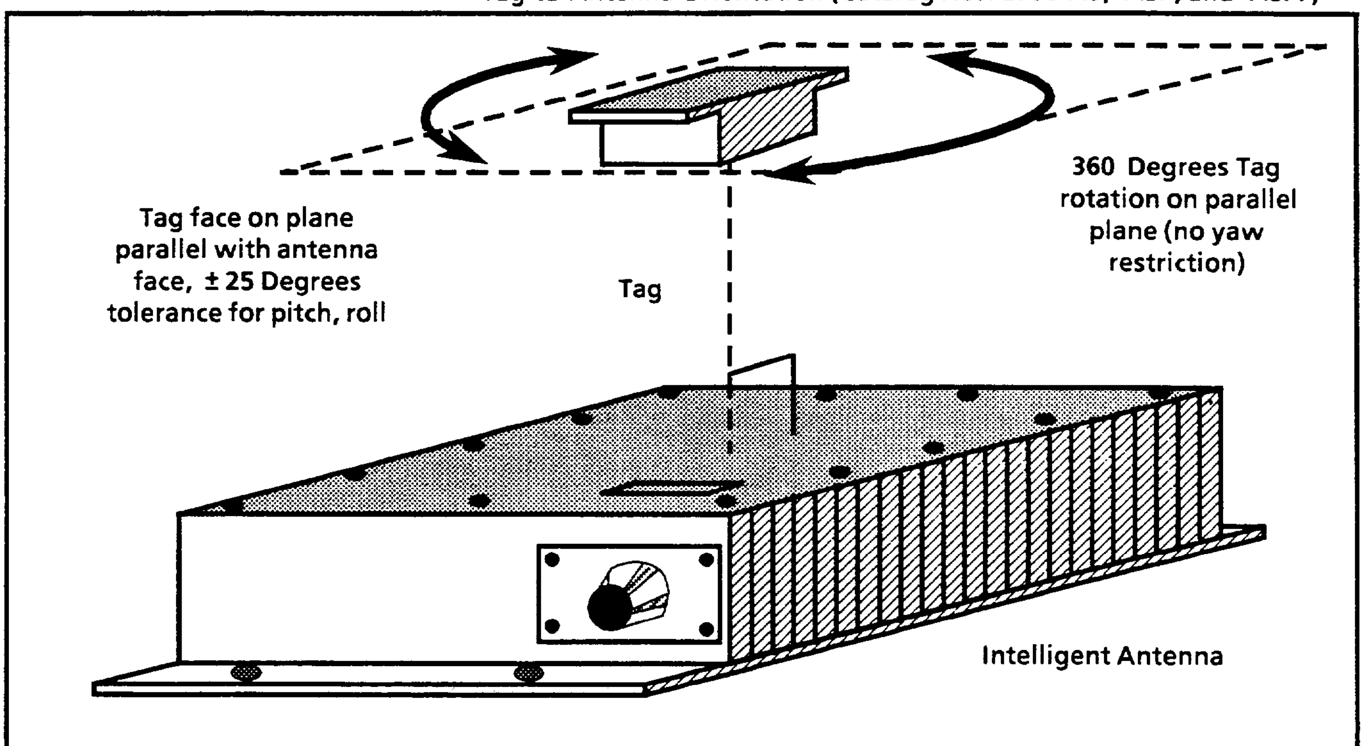
For orienting RF tags to the Catalog No. 2750-AS, -ASP or -ASPF antennas (see Figure 4.6):

- The face of the tag must be on a plane parallel to the plane of the antenna face, with a tolerance of ±25° pitch or roll offplane (see Fig. 4.7 for pitch, roll examples).
- The tag may be rotated 360° about its center axis.

For orienting RF tags to the remote antenna head of Catalog No. 2750-ASD, -ASPR or -ASPRF antennas, more stringent guidelines apply (see Fig. 4.7):

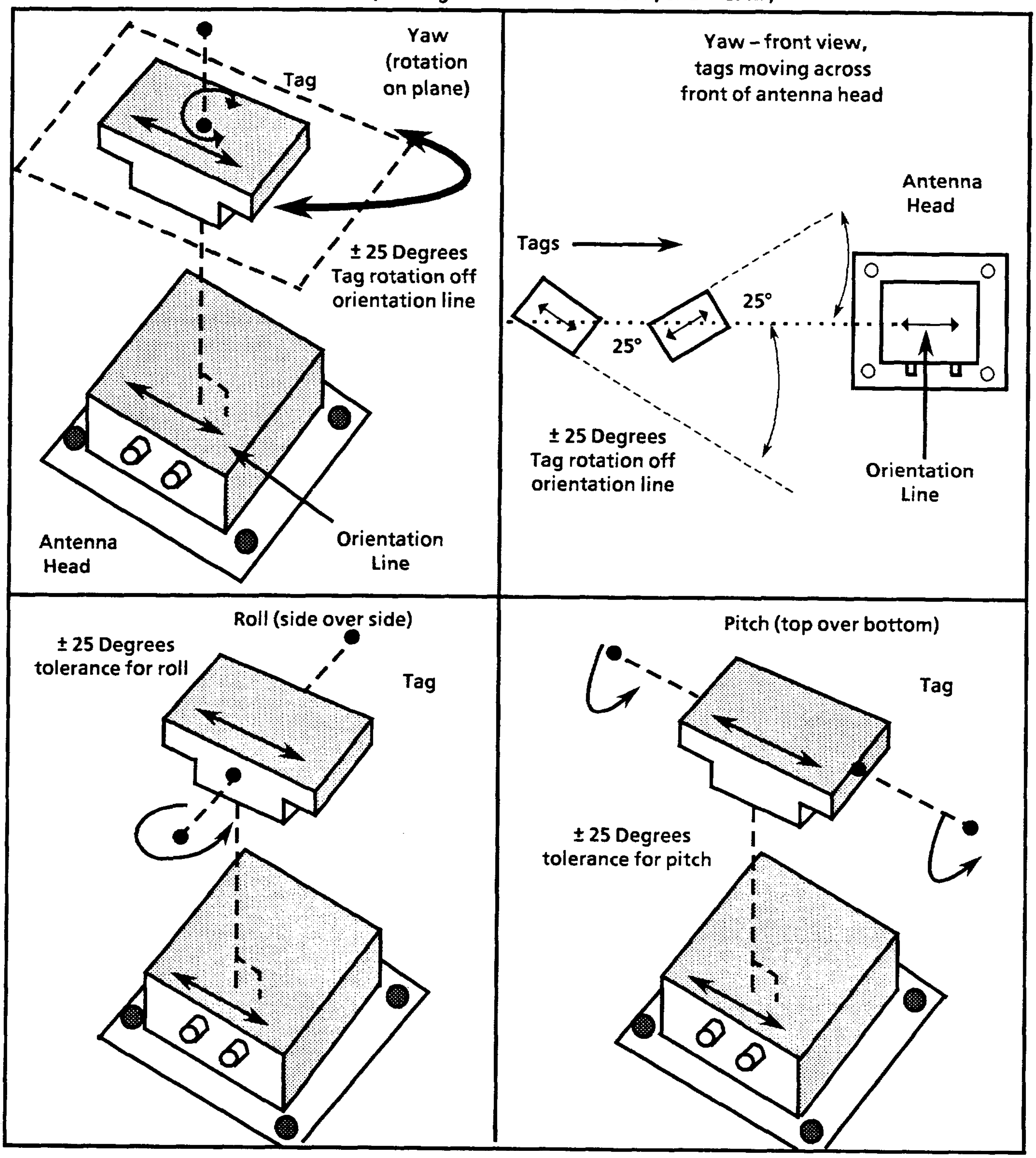
- Antenna remote head and tags are marked with an orientation line. Line up the orientation lines of tags to that of the antenna (±25° yaw).
- The face of the tag must be on a plane parallel to the plane of the antenna face, with a tolerance of ±25° for pitch or roll. **Note:** Tag may be offplane in one axis only.

Figure 4.6
Tag-to-Antenna Orientation (Catalog Nos. 2750-AS, -ASP, and -ASPF)



Tag-to-Antenna Orientation
(continued)

Figure 4.7
Tag-To-Antenna Orientation
(Catalog Nos. 2750 -ASD -ASPR, and -ASPRF)



Moving Tag Speed Limitations

If RF tag transactions are to occur while the tag is moving, tag speed limitations apply. For maximum tag speeds for each tag type, refer to the specifications for each tag type listed in Appendix A. For more information, call your Allen-Bradley representative.

Note: The tag speeds listed are given for the maximum antenna-to-tag distance for each tag. If you decrease tag-to-antenna distance, the capture window width and maximum tag speed decreases in proportion.

Testing Tag Transactions

As a final test, after connecting and positioning the antenna, try to execute your antenna transactions with RF tags. To do this, place tags within the antenna capture window where they would normally travel during system operation, and send a transaction command to the antenna (see page 9-20 for IDP Perform command, or page 6-8 for ASCII Read Tag command).

If tag transactions are not successful, check the return code in the antenna response for type of failure. You may have to reposition tags, reposition the antenna, reset the RF level, or make other adjustments.

For more troubleshooting information, see Chapter 10.

Positioning the Object Detect Device

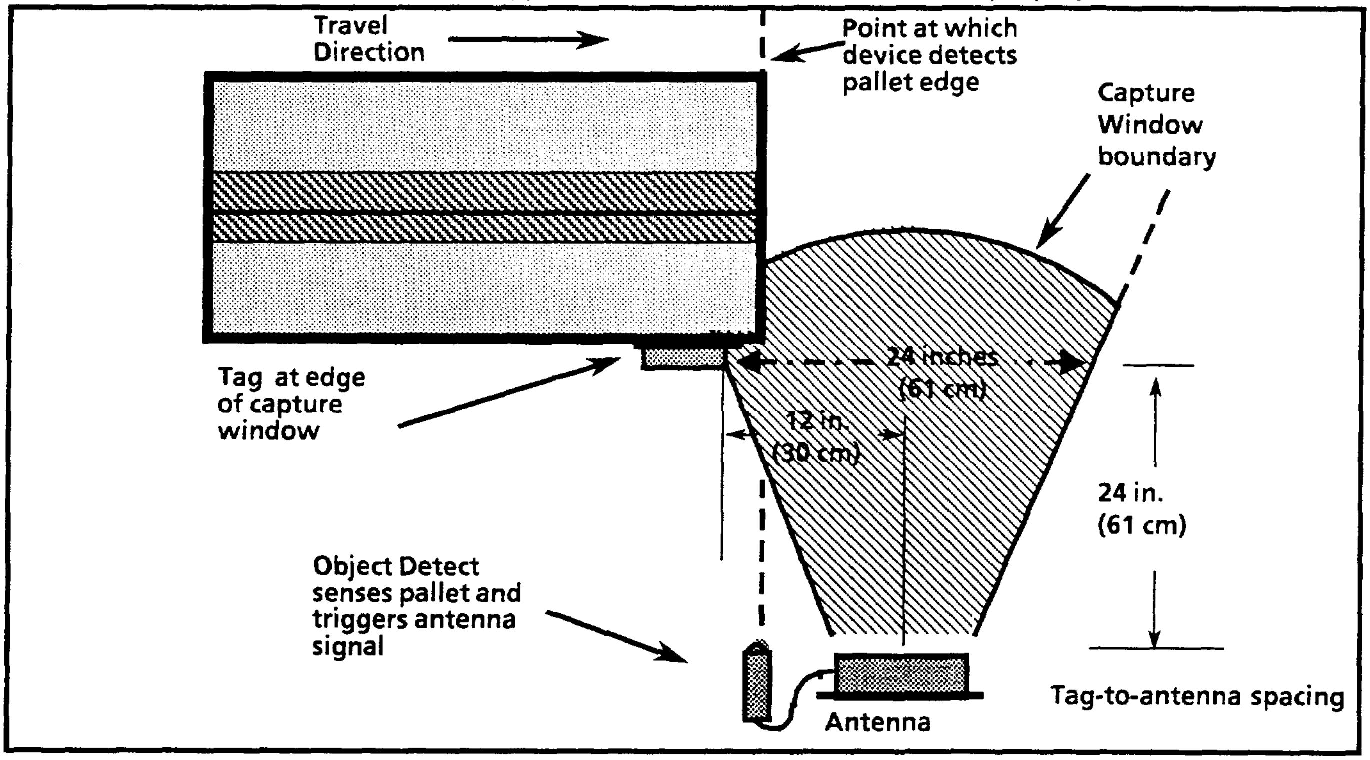
The object detect device detects the presence of the object to which a tag is attached.

Correct positioning of the object detect will depend on the specific application, including whether the tag is moving during transactions, and where the tag is located, relative to the detectable edge of the object to which the tag is attached.

Note: Never place the object detect device in the direct path of the signal between the tag and the antenna. Keep the device outside the capture window boundaries if possible.

Positioning the Object Detect Device
(continued)

Figure 4.8
Example Object Detect Placement
(approximate dimensions used, for example purposes)



Moving Transactions

For moving tag transactions, position the object detect device to trigger when the tag crosses the leading edge of the capture window. As a guideline, the capture window width can be estimated as roughly equal to the antenna-to-tag spacing, as shown in Figure 4.8.

Example Positioning – Refer to Figure 4.8. The object detect is placed so the leading edge of the pallet trips the object detect just when the RF tag enters the capture window. The antenna transmission begins at that moment. This maximizes the time for a tag to remain in the window.

Stationary Transactions

For stationary transactions, place the object device so the device goes active when the tag is at its stop location. (**Note:** The antenna emits a weak "idle" signal when powered up and not transmitting. This signal can turn on a read/write tag, and cause battery drain. Do not stop a read/write tag within idle range of the antenna for long durations – see the "Idle" dimensions in the table in Figure 4.3, page 4-5).

Chapter 5 Antenna Installation and Connections

Chapter Objectives

This chapter explains how to connect the Allen-Bradley 2750-AS series Intelligent Antenna, including how to:

- Remove and replace wiring access cover plate.
- Configure and connect Allen-Bradley 2750-PA power supply to the antenna, and check antenna power up.
- Connect the host to the antenna, and set the power-up default baud rate and transmission mode.
- Connect the object detect device (optional) to the antenna.
- Connect the remote antenna head to the antenna (used with 2750-ASD, -ASPR, and -ASPRF antennas).

Before Installing the Antenna

Have the following information on hand in order to connect the antenna to the other RFID components:

- Desired antenna mounting location (including remote head, if applicable), and orientation.
- Wiring distances from the antenna to host, power supply, and to the object detect device.
- Type of host communication (RS-232 or RS-422).
- Transmission mode. (ASCII, DF1, etc.)
- Power-up baud rate setting.

Required Hardware and Equipment

- Allen-Bradley Intelligent Antenna, Catalog No. 2750-AS, -ASP, -ASD, -ASPR, -ASPF, or -ASPRF.
- Cables – Two 10-foot (3.05 m) coaxial cables (Catalog No. 2750-C1) for connecting remote head (Catalog No. 2750-H1), if applicable (2750-ASP, -ASPR, -ASPRF).
- Power Supply – Allen-Bradley 2750-PA Power Supply.
- Shielded, twisted pair cabling from host serial port (RS-232 or RS-422).
- (Optional) object detect (presence sensing) device.

Wiring Cover Plate Removal

To remove the cover plate, remove the retaining screws at the four corners of the cover plate(see Figure 5.1).

CAUTION: When removing or handling the cover plate, be careful not to remove, damage, or lose the "O" ring surrounding the wiring access window.

Upon removal of the cover plate, you will see the connectors and jumper pins you need to access when installing and connecting the antenna (see Figure 5.2).

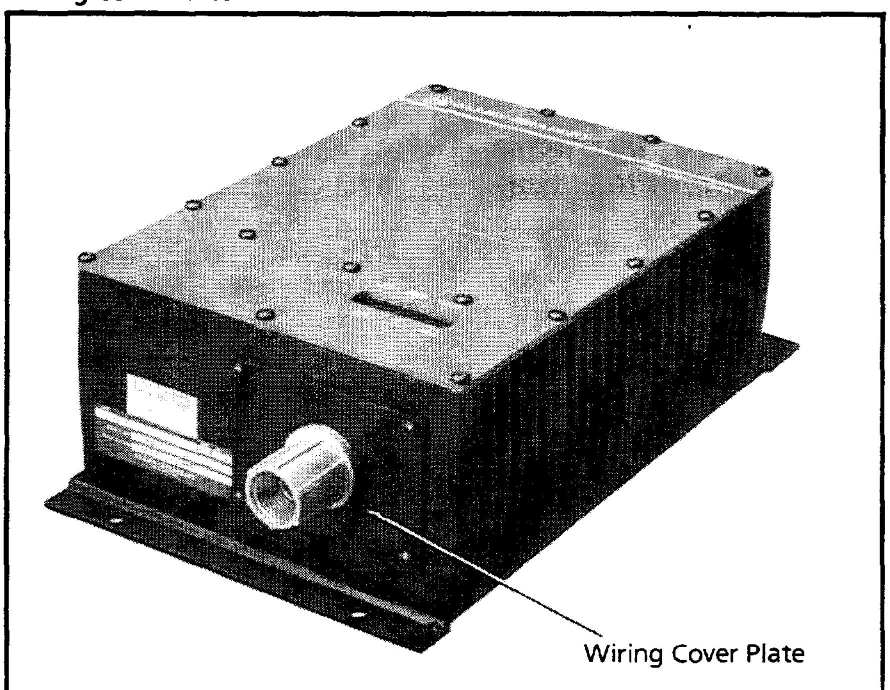
Note: Be sure to thread wires through the opening in the wiring cover plate before connecting to the antenna.

When reinstalling the cover plate:

1. Make sure the "O" ring is in place.
2. Install and tighten the retaining screws at the four corners of the cover plate. Torque to 14 inch-pounds.

Note: The wiring access opening is designed for use with a conduit fitting. The fitting also serves as a chassis ground connection. If power grounding wires are used, you may attach them to the lug assembly on the interior face on the access cover.

Figure 5.1
Wiring Cover Plate



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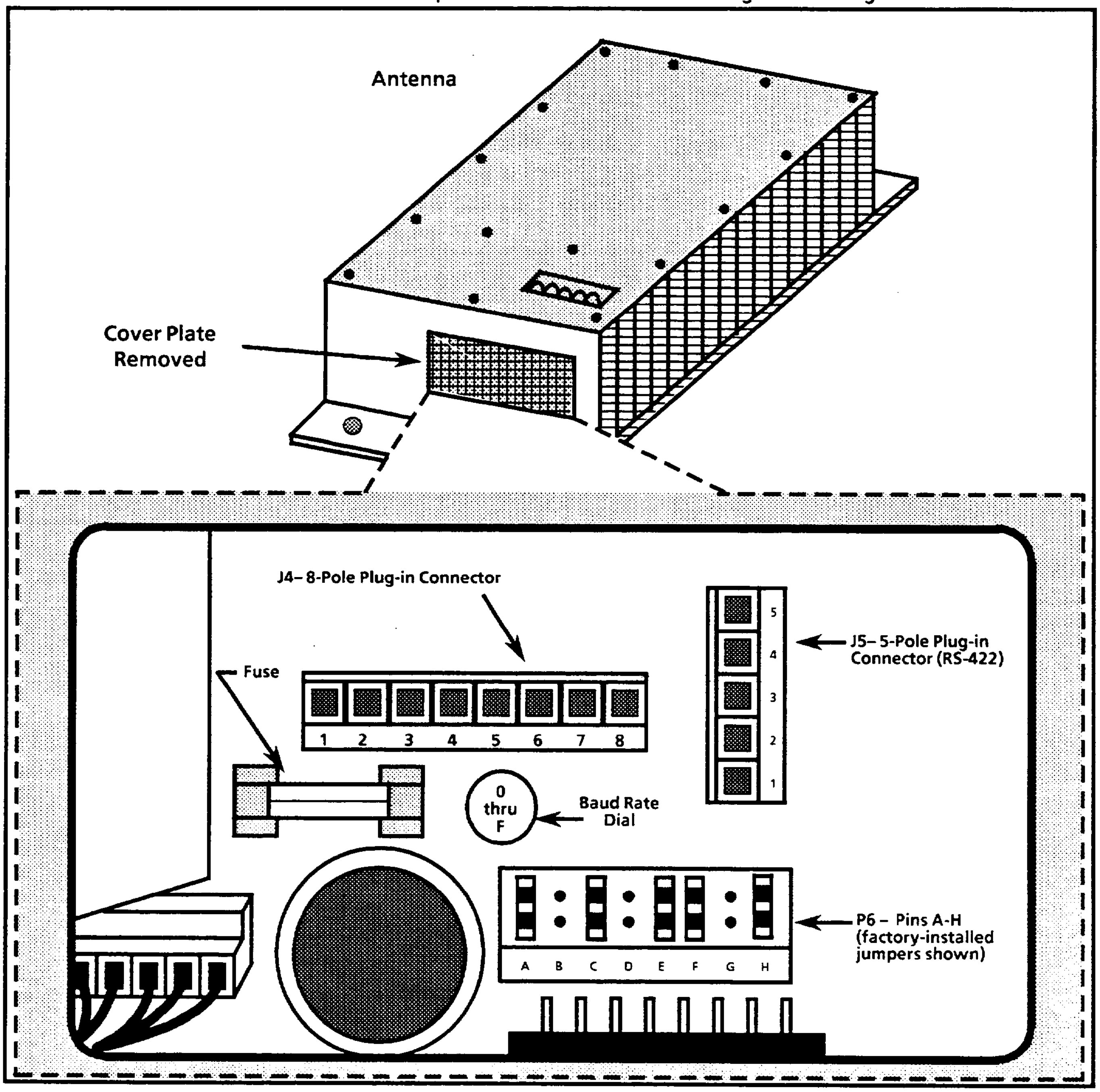
Wiring Cover Plate Removal
(continued)

Figure 5.2
Component Locations – View Through the Wiring Access Window



Connecting Power to the Antenna

Intelligent Antennas require a 24VAC power source (see Appendix A for antenna electrical specifications). The Allen-Bradley Bulletin 2750-PA Power Supply is designed specifically to meet the antenna power specifications. Refer to Publication No. 2750-2.23, "Product Data, Bulletin 2750 Power Supply," for mounting dimensions.

Power Supply Configuration

Configure the 2750-PA Power Supply terminals H1, H2, H3, and H4 according to the input line voltage (see Figure 5.3). Use #14 gage electrical wire.

WARNING: Do not attempt to connect live power wires to the antenna or power supply. Make sure no power is connected to the power supply when wiring the power supply or connecting power supply to antenna. Crossing of live wires or touching a live terminal can result in personal harm, and/or damage to equipment.

Power Supply Connection

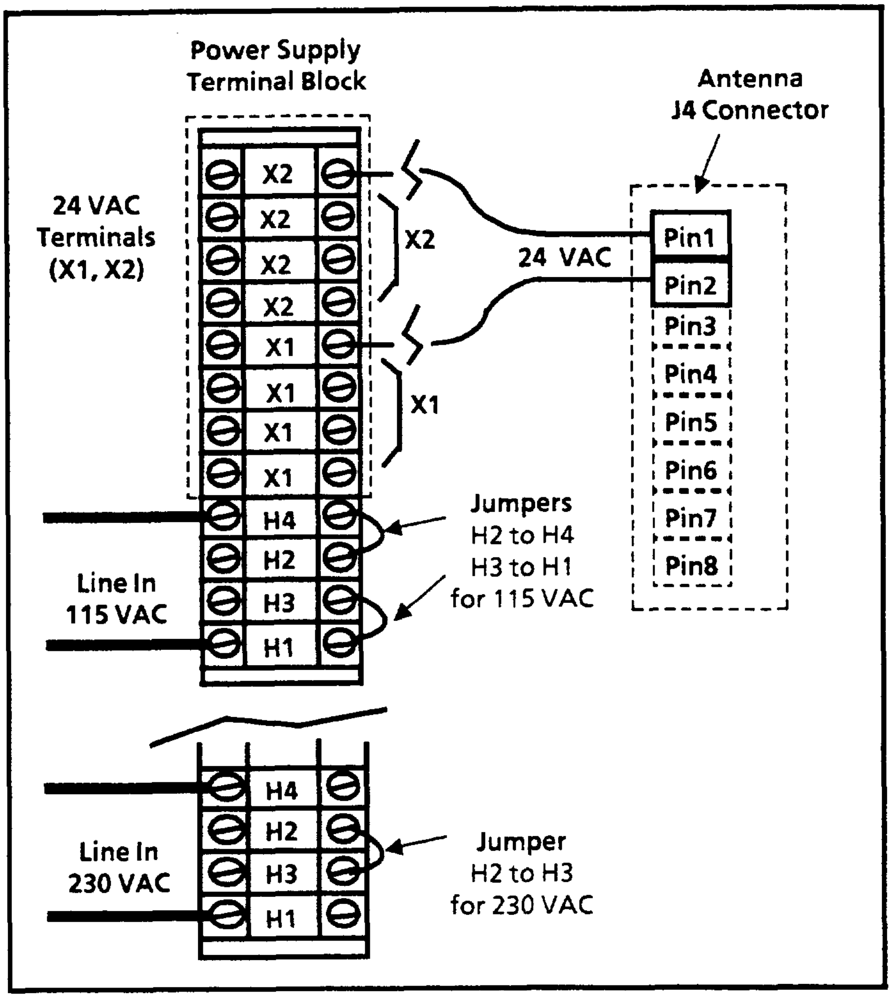
To connect the power supply to the antenna, use #14 gage electrical wire – 200 feet maximum length for 2750-PA Power Supply. Refer to Figure 5.3:

1. Remove connector J4 from the antenna (see Figure 5.2).
2. Connect one wire from any "X2" terminal on the 2750-PA Power Supply to Pin 1 on connector J4 (see Figure 5.3). Then connect any "X1" terminal to Pin 2 on J4.
3. Plug the connector J4 into its socket.

CAUTION: Do not route the input lines to the antenna (24 VAC power supply, the object detect, and the host communication lines) in conduits or cable trays parallel to 115 VAC (or higher voltage) control or power lines. Route input lines across control or power lines at 90 degree angle.

Power Supply Connection
(continued)

Figure 5.3
2750-PA Power Supply Wiring



Check Power Connection

To check the power connection to the antenna:

1. Connect power to the power supply.

2. Check the diagnostic LEDs on the antenna. Several LEDs flash ON and OFF for about 20 seconds. The green POWER LED stays ON (**Note:** If the antenna is configured for object detect mode disabled, the OBJECT DETECT LED will remain ON also).

3. Disconnect power to the power supply.

If the LEDs did not go ON, recheck your power connections and power supply configuration. Also check power supply fuse, and antenna main fuse (see Figure 5.2).

Connecting Host Communication

This section tells how to connect host communication to the antenna, and set antenna communication parameters. For the host side connector pin-out for the communication cable, refer to the user manual for the host or communication interface module you are using.

Note: Use shielded, twisted pair communication cable.

Connecting RS-232

To connect RS-232 communication lines to the antenna, refer to Figure 5.4, and complete the following steps:

1. Remove connector J4 from the antenna (see Figure 5.2).
2. Connect communication wires to pins 6, 7, and 8 of connector J4 (see Figure 5.4).
3. Install a jumper pin at position "H" on the P6 connector (**Note:** Remove the jumper at "G" if one is there). This is the factory-installed setting (factory settings shown in Figure 5.2).
4. Plug the connector J4 into its socket.

CAUTION: Never install jumpers at both "G" and "H" on connector P6 at the same time.

Connecting RS-422

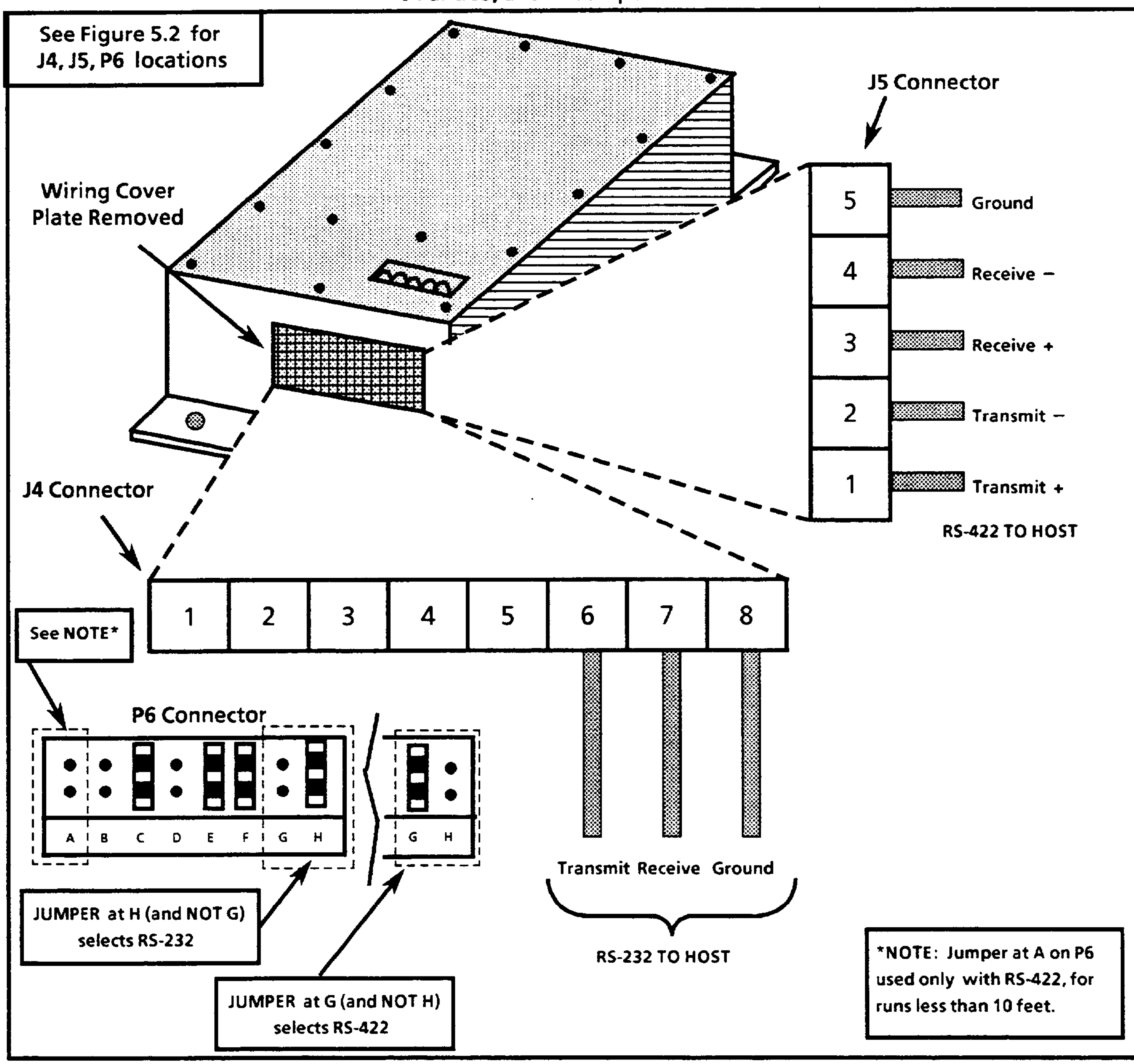
To connect RS-422 communication lines to the antenna:

1. Remove connector J5 from the antenna (see Figure 5.2).
2. Connect communication wires to connector J5 as shown in see Figure 5.4.
3. Install a jumper pin at position "G" on the P6 connector (**Note:** Remove the jumper at "H" if one is there).
4. Plug the connector J5 into its socket.

Note: For RS-422 cable runs of less than 10 feet, install a jumper pin at "A" on P6 (refer to Figure 5.4). This places a 100-ohm termination on the receive line. The maximum cable length for RS-422 format is 2000 feet.

Connecting Host Communication
(continued)

Figure 5.4
Communication Wiring Pinouts for Connectors J4 and J5, and P6 Jumpers



Selecting Power-up Default Baud Rate

Upon any reset or power up, the antenna reverts to the baud rate set by the antenna baud rate dial (see Figure 5.2) for host communication. The factory setting of the dial is 9600. To change the power-up default baud rate:

1. Refer to Table 5.A for the baud rate dial settings.

2. Set the dial for the desired baud rate.

The antenna will communicate at the new baud rate upon power up or reset.

Note: The antenna baud rate can be set by a command from the host (see "Set Interface Configuration Command," page 8-15), though the antenna will always revert to the dial baud rate upon power-up or reset.

Table 5.A
Baud Rate Dial Settings

Baud Rate Dial Setting	Default Baud Rate
0	300
1	1200
2	2400
3	4800
4	9600
5	19200
6 through F	9600

Selecting "Byte-Swapping" Mode

Data communication between the antenna and the host is conducted with "Byte Swapping" enabled or disabled (see "Transmission Modes" on page 9-3 for information).

- To enable the byte-swapping mode, install a jumper at location F of connector P6 (refer to Figure 5.2). This is the factory setting.

- To disable the byte-swapping mode, remove the jumper from location F of connector P6.

Note: You must reset or power-up the antenna to activate the new mode.

Connecting the Object Detect Device

Intelligent Antennas can be set up to operate with an object detect device as a trigger for RF operations. This section tells how to connect different types of object detect devices.

Object Detect Connection Procedure

Before you connect the object detect device to the antenna, determine if the device is a two-lead or three-lead device.

Next, determine if the device operates as a current source or current sink. If necessary, consult the wiring information with the device, and compare with Figure 5.5 or 5.6. For two-lead devices, refer to the connection diagrams in Figure 5.5. For three-lead devices, refer to Figure 5.6.

Note: The antenna's object detect input can provide power to object detect devices – from 10 VDC to 30 VDC, 50 mA.

CAUTION: Input voltage to the object detect must be less than 30 VDC. Higher voltage DC input or AC input will damage the antenna.

Once the type of device is determined:

1. For a current source device, place jumper pins at locations B and D.

2. For a current sink device, place jumper pins at locations C and E.

3. Connect object detect device leads to connector J4, pins 3, 4, and 5, according to type of device (i.e., current source or current sink).

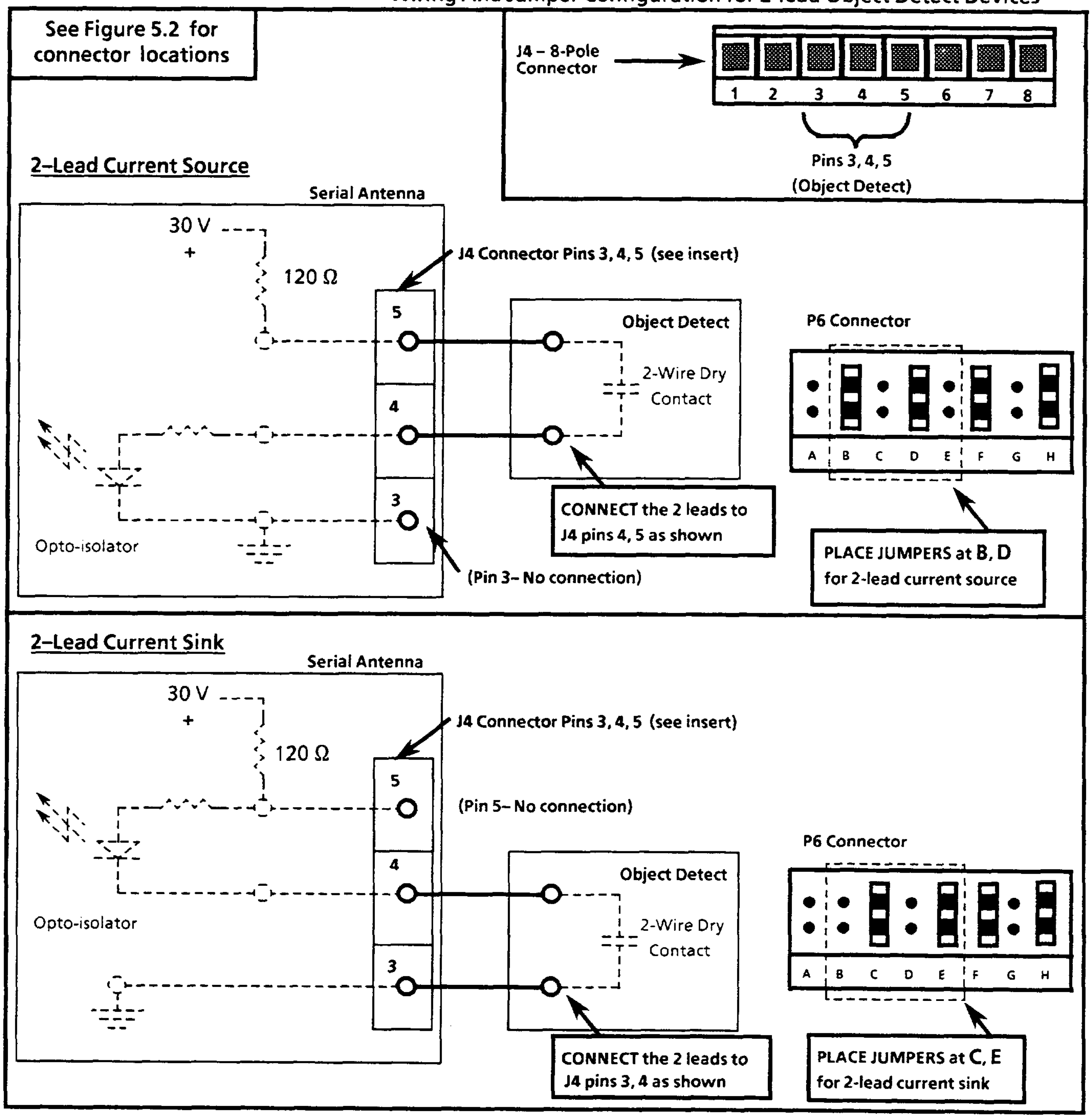
   Note: The user determines whether to connect a two-lead device as current source or current sink. The factory-installed setting is current sink (jumper pins at C and E).

4. Plug connector J4 into its receptacle place.

Object Detect Connection Procedure (continued)

CAUTION: Be sure to install the P6 jumpers for the type of object detect device used. Using incorrect jumper settings or connections may damage the object detect and/or the antenna.

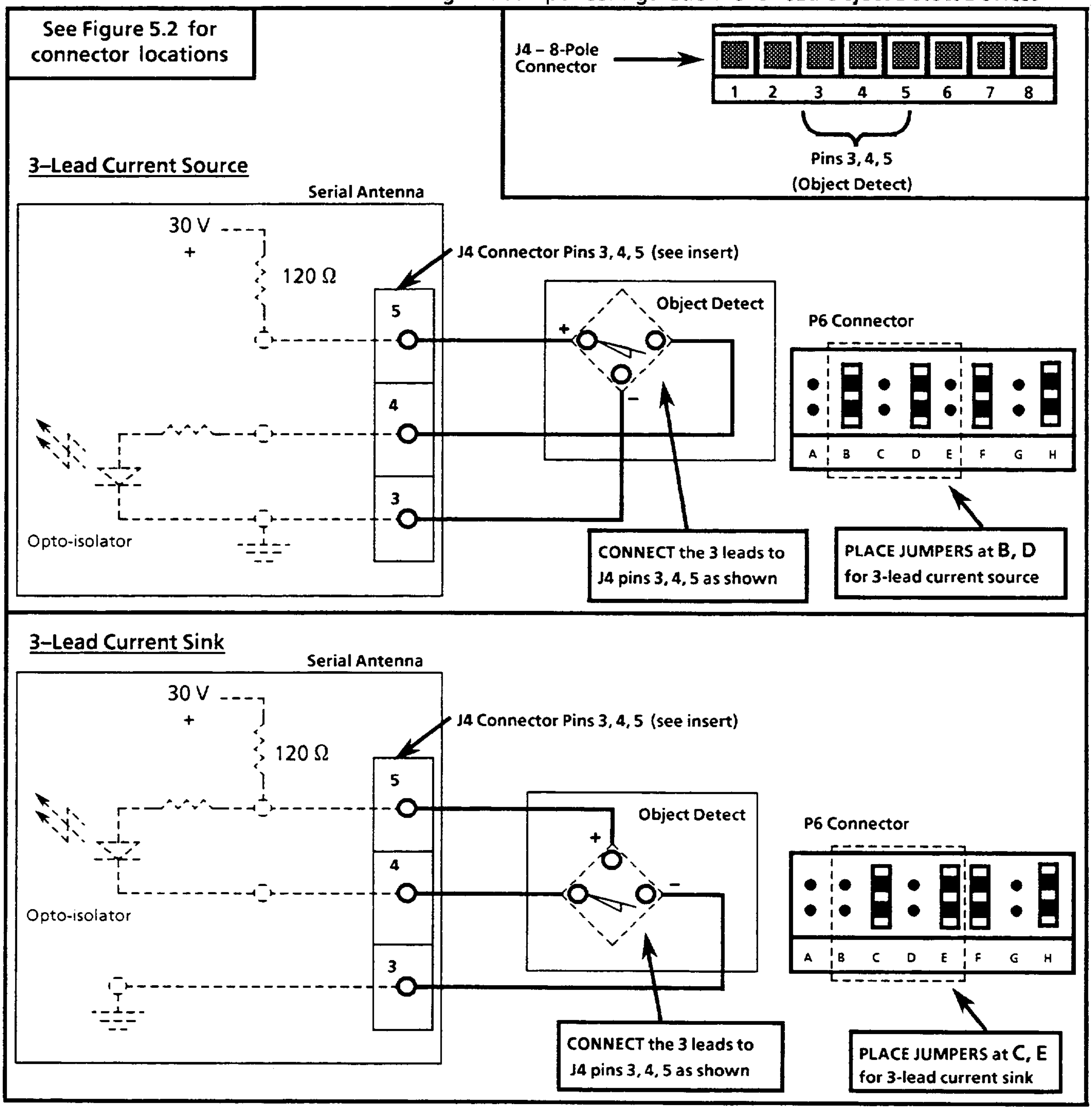
Figure 5.5
Wiring And Jumper Configuration for 2-lead Object Detect Devices



Object Detect Connection Procedure (continued)

CAUTION: Be sure to install the P6 jumpers for the type of object detect device used. Using incorrect jumper settings or connections may damage the object detect and/or the antenna.

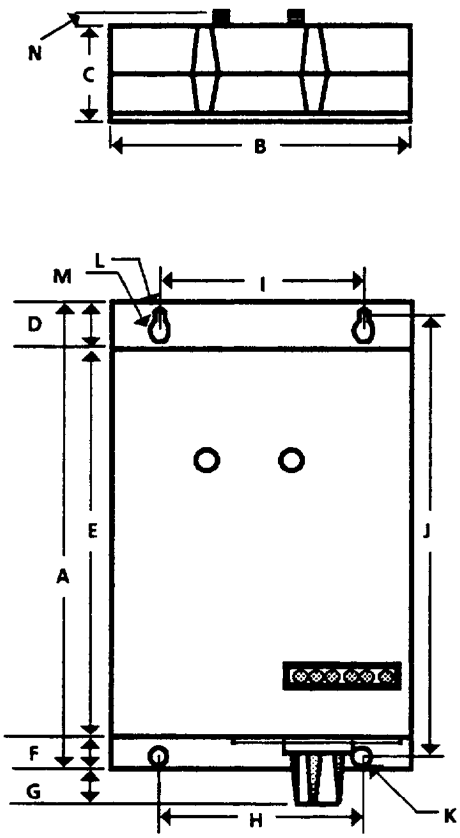
Figure 5.6
Wiring And Jumper Configuration for 3-lead Object Detect Devices



Antenna Mounting Dimensions

Antenna body mounting dimensions are shown in Figure 5.7 (Note: Figure 5.7 shows Catalog No. 2750-ASD, which includes RX and TX receptacles for remote head connection. The same body dimensions apply to other antennas without the receptacles).

Figure 5.7
Antenna Body Mounting Dimensions (2750-ASD shown).



Dimensions in Inches (mm)	
A	13.5 (342.9)
B	7.76 (197.1)
C	4.37 (111.0)
D	1.5 (38.10)
E	11.00 (279.40)
F	1.00 (25.40)
G	.45 (11.43)
H	5.00 (127.00)
I	5.00 (127.00)
J	12.87 (326.89)
K	.31 Dia. (7.87)
L	.31 Dia. (7.87)
M	.55 Dia. (13.97)
N for ASD	.249 (6.3)

Mounting and Connecting the Remote Antenna Head

If you are using an antenna with remote head, refer to the dimensions in Figure 5.8.

Be sure to mount the antenna body within connecting distance of the remote head – the cables are 10 feet (3.05 m) in length.

Connect the remote antenna head to the antenna body using the two coaxial cables (Catalog No. 2750-C1):

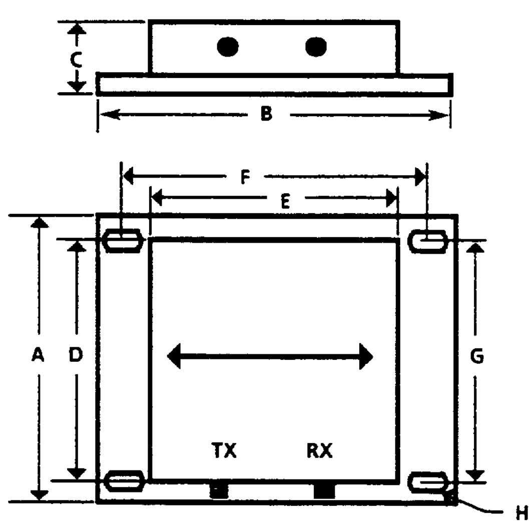
1. Connect one end of one cable to the RX connector on the antenna body. Connect the other end to the RX connector on the remote head. Torque to 7-10 inch pounds.

   Note: The minimum bend radius of the Catalog. No. 2750-C1 cable is 2 inches (51 mm). Also, route cables so that there is no tension on the cable connectors.

2. Connect the TX connectors of the antenna body and remote head with the other coaxial cable. Torque to 7-10 inch pounds.

   Note: The Catalog No. 2750-C1 coaxial cable pairs are color-coded with color bands at each cable end (one cable is marked red, the other blue). If you are using more than one antenna, we suggest you use one color cable for the TX lines and the other color for RX lines throughout your system.

Figure 5.8
Remote Antenna Head Mounting Dimensions



Dimensions in Inches (mm)	
A	4.12 (104.65)
B	5.12 (130.04)
C	1.25 (31.75)
D	3.54 (89.91)
E	3.5 (88.90)
F	4.12 (104.65)
G	3.54 (89.91)
H	.25 Dia. (6.35)

Chapter 6 ASCII Commands

Chapter Objectives

The Bulletin 2750-AS series Intelligent Antennas can accept ASCII protocol commands. Read this chapter to learn how to set up the serial communication format, use the ASCII commands, and interpret antenna responses.

Separate sections in this chapter describe how to:

1. Set up the host port and antenna communication lines.
2. Select ASCII protocol.
3. Operate the antenna using ASCII commands. Tables are included to help you encode command fields and decode response fields.

Setting the Host Port and Communication Lines

Set up the host serial port and connect communication lines before selecting ASCII protocol, as follows:

RS-232 or RS-422: Connect either type of serial communication lines. See "Connecting Host Communication," page 5-6.

Baud Rate: Set the host baud rate to match the antenna baud rate. To set the antenna baud rate, use the antenna's default baud rate dial:

1. Set the baud rate dial to desired baud rate setting (see "Selecting Power-up Default Baud Rate," page 5-8).
2. Power up the antenna (see "Connecting Power to the Antenna," page 5-4). Upon power-up, the antenna will use the default baud rate.

Other Parameters – Set the host port to no parity, one stop bit, 8 bits/character.

Selecting Protocol

ASCII is the default protocol for all Intelligent Antennas. Whenever the antenna is powered up or reset, it will come up using ASCII protocol.

Whenever any DF1 protocol command is received, the antenna will automatically switch to DF1 protocol (see Chapters 8 and 9).

To reset the antenna for ASCII, send three straight ASCII carriage return (<CR>) characters to the antenna:

<CR><CR><CR>

Conventions and General Guidelines

Use the general guidelines, and note the conventions listed below, when using ASCII protocol (see also the "ASCII Commands and Responses" section in this chapter):

Brackets – Brackets are a convention used to distinguish characters and fields in the command/response formats (do not actually enter them when encoding):

< >	Denotes a single ASCII character, such as <CR>, the ASCII carriage return.
[ ]	Denotes an optional field or character string, as in [REPCNT], or E[cho].

Using Spaces Between Fields – Use one or more ASCII space characters (<SP>) to separate the fields in the commands as specified with these symbols:

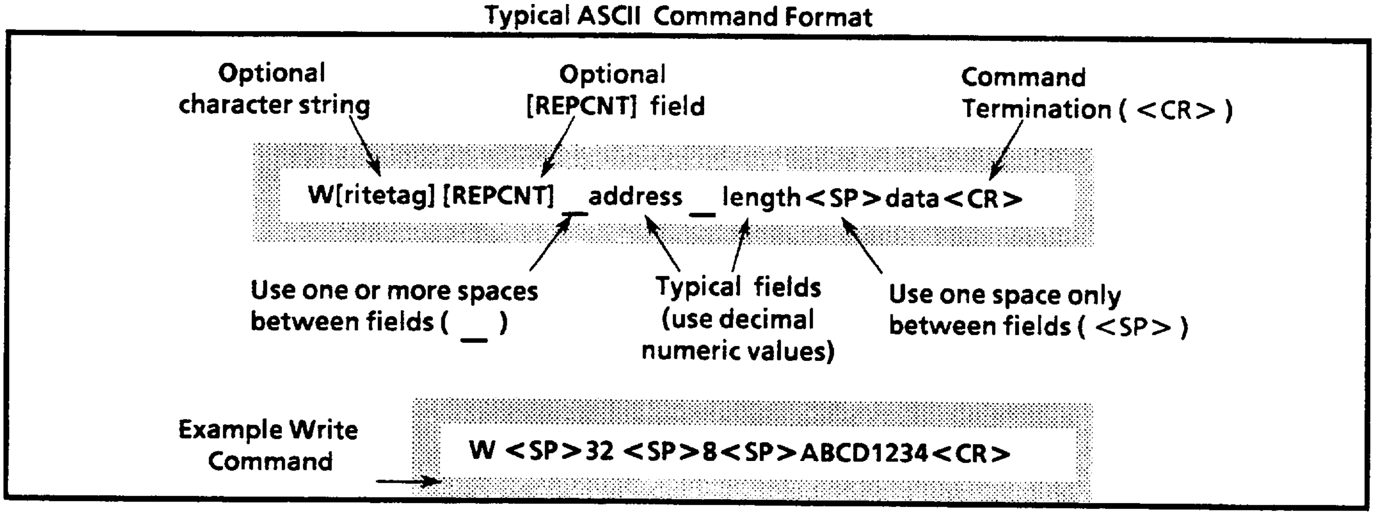
<SP>	Where (<SP>) is shown, use one and **only one** space character (<SP>).
__	Where the underscore (__) is shown, use one or more space characters as desired.

Upper or Lower Case – Use either case when encoding the commands as desired.

Decimal Values – Use decimal values where numeric values are required. All numeric values in the antenna responses are decimal values. **Note:** The antenna uses hexadecimal values internally; when using ASCII, the antenna automatically converts the decimal values you supply (such as **address**) to hexadecimal.

Termination – End each command with a single ASCII carriage return (<CR>). Each response from the antenna ends with a single carriage return (<CR>).

Figure 6.1
Typical ASCII Command Format



Conventions and General Guidelines *(continued)*

Field Size – Field sizes are listed for each field in a response. Fields in the commands can be any size as long as the field values are appropriate (except data fields – see "Antenna Command Fields" below). Leading zeros (0) are ignored.

Invalid Command – If the antenna receives a message not recognized as valid ASCII command, the antenna responds with:

???<CR>

Antenna Command Fields

Most of the antenna commands begin with the descriptor field (such as "W[ritetag]"). Other fields are described below:

REPCNT The **REPCNT** (repeat count) is an optional field used to repeat a tag command (such as read tag or write tag). Enter the REPCNT value after the command descriptor. **Do not** insert a <SP> between the descriptor and the REPCNT. The range is from 0 to 255, where 0 indicates continuous repeat (until another command is received by the antenna). With no entry, REPCNT defaults to one.

address The **address** (start address) is used in Read Tag and Write Tag commands to indicate the first tag byte accessed (the antenna converts the decimal address value you supply to the hexadecimal address). Set to 0 for programming the programmable tags (unless antenna is configured for programmable, addressable tags). Set to minimum of 32 for read/write tags.

length The **length** is used in Read and Write Tag commands to indicate the number of consecutive bytes read or written to, beginning with the start address. The length must match the number of data bytes included in the command. Length value plus address value must not exceed tag memory capacity (number of bytes in tag memory).

data The **data** field consists the actual bytes read from or written to the tag. The type of data and amount of data depends on tag type (see Table 7.B, page 7-3) and antenna configuration. The maximum data field size in a command varies – see Read Tag, Write Tag, and Multiple commands.

Antenna Response Fields

The antenna response to most commands begins with TNS and RC fields, which are described below:

TNS The **TNS** (transaction number) is a two-digit field (range 0-99) which begins the antenna response. The TNS is zero (0) when ASCII protocol starts, and is incremented with each subsequent response.

RC The **RC** (return code) is a three-digit field which follows the TNS number in the antenna response. See Table 6.A or 6.C, depending on command type (refer to the specific command description).

ASCII Commands and Responses

This section lists and describes the valid command formats (and antenna responses) for using the ASCII protocol. Each command description typically includes:

- The command format and antenna response format
- A description of the command's use
- An example command and antenna response, with an explanation of the examples.

Several tables (Tables 6.A to 6.F) are included in this section describing the command and response fields. Use the tables as necessary to encode command fields or decode responses.

Antenna Status Command

Command Format:
<CR>

Response Format:
OK<CR>

Use the Antenna Status command to see if the antenna is set to ASCII protocol. A response (OK) is returned if the ASCII protocol is active. Otherwise no response is returned.

Initialize Command

Command Format:
I[nitialize]<CR>

Response Format:
(No response sent.)

Use the Initialize Command to reset the antenna. No response is transmitted. **Note:** When you reset the antenna, the default protocol is the ASCII protocol. The antenna will switch to DFI/PCCC/IPP protocol upon receipt of any command using this protocol.

Echo Command

Command Format:
E[cho]<SP>data<CR>

Response Format:
TNS<SP>RC<SP>data<CR>

Use the Echo command to test the communication link to the antenna. The **data** field may consist of up to 234 characters. The antenna response includes return code (RC) and the exact contents of the Echo command data field. Any data variation may indicate a communication fault. The return code values are listed in Table 6.A, page 6-7.

Example Command:
E<SP>HELLO<CR>

Example Response:
01<SP>000<SP>HELLO<CR>

The RC value (000) in the response above indicates success, as is further indicated by the correct data in the response.

Get Sensor Configuration Command

Command Format:
G[etconfig]<CR>

Response Format:
TNS<SP>RC<SP>tagtype<SP>odmode<SP>odtimeout<SP>rfstrength<CR>

Use the Get Sensor Configuration command to retrieve the configuration settings for the antenna's read and write tag operations. The antenna response includes these fields: tag type (tagtype), a three-digit field; object detect mode (odmode), one-digit; object detect timeout (odtimeout), five-digit; and RF field strength (rfstrength), one-digit. The response fields are listed in Tables 6.A and 6.B, page 6-7.

Example Command:
G<CR>

Example Response:
03<SP>000<SP>016<SP>1<SP>00025<SP>5<CR>

As shown in Table 6.B, the **tagtype** field (016) indicates a 2K Read/Write tag. The **odmode** (1) indicates enabled object detect mode. The **odtimeout** field (00025) indicates a 2.5 second timeout (25 × 100 milliseconds). The **rfstrength** field (5) indicates a maximum RF field strength.

Set Sensor Configuration Command

Command Format:
S[etconfig]_tagtype_odmode_odtimeout_rfstrength <CR>

Response Format:
TNS<SP>RC<CR>

Use the Set Sensor Configuration Command to set the configuration settings for the antenna's read and write tag operations. The command includes these fields: **tagtype**, **odmode**, **odtimeout**, and **rfstrength**.

The values for setting the configuration fields are listed in Table 6.B the return codes in Table 6.A, page 6-7.

Note: When entering values for the different fields, use any number of digits as long as the entry is valid for that field.

Example Command:
S<SP>16<SP>1<SP>26<SP>3<CR>

Example Response:
05<SP>000<CR>

Set Sensor Configuration Command (continued)

In the example command above, the **tagtype** value (16) sets command for a 2K R/W tag (see Table 6.B). The **odmode** (1) enables object detect mode. The **odtimeout** value (26) sets a 2.6 second (2600 millisecond) timeout. The **rfstrength** value (3) sets RF field strength. The **RC** (000) in the example response indicates a successfully completed configuration.

Table 6.A
Antenna Response Return Codes

RC Value	Meaning
000	Success
130	Command valid, execution unsuccessful

Table 6.B
Configuration Field Values

Field	Field Value (decimal)	Applicable Antenna Type	Meaning
Tag Type (tagtype)	00	All Antennas	6-digit, 20- or 40-character Read Only
	16		2K Read/Write
	17		8K Read/Write
	32		6-digit programmable①
	33		20-character programmable①
	34		40-character programmable①
	64		6-digit programmable, addressable① ②
	65		20-character programmable, addressable① ②
	66		40-character programmable, addressable① ②
	96	2750-ASPF, ASPRF	6-digit Fast Read
	97	2750-ASPF, ASPRF	20-character Fast Read
	98	2750-ASPF, ASPRF	40-character Fast Read
Object Detect Mode (odmode)	0		Disabled
	1		Enabled
Object Detect Timeout (odtimeout)	(any up to 65, 535)		Multiply value in field by 100 to calculate timeout in milliseconds (a value of 0 indicates timeout is disabled)
RF Field Strength (rfstrength) for All Antennas, except 2750-ASD	0		Disabled
	1		Minimum
	2		Low
	3		Medium
	4		High
	5		Maximum
RF Field Strength (rfstrength) for 2750-ASD	0		Disabled
	1		Low
	2		Low
	3		Low
	4		High
	5		High

① Only the programming antennas, Catalog Nos. 2750-ASP, -ASPR or -ASPRF can program tags.

② In order to use this setting, tag memory must first be fully programmed in the corresponding programmable mode (i.e., 6-digit, or 20- or 40-character programmable mode).

Read Tag Command

Command Format:

R[eadtag] [REPCNT]_address_length<CR>

Response Format:

TNS<SP>RC<SP>ATTM<SP>length<SP>data<CR>

Use the Read Tag command to perform a tag read. The repeat count (**REPCNT**) field is optional; use it to specify the number of Read Tag command repeats. The **address** field indicates the starting point of the tag read. The maximum **length** is the lesser of tag size or 226.

The antenna response includes **ATTM**, the number of read attempts made by the antenna, **length**, the number of data bytes read, and the returned tag **data**. Each response field (except **TNS** and **data**) has three digits. The return code (**RC**) is described in Table 6.C. below.

Example Command:

R2<SP>15<SP>10<CR>

Example Responses:

06<SP>002<SP>001<SP>010<SP>ABCDEFGHIJ<CR>
07<SP>001<SP>255<SP>010<SP>0000000000<CR>

In the example command above, the R2 (Read Tag with REPCNT 2) causes a READ to be performed twice (thus the two responses). The **address** value (15) starts the READ at address 000F. The **length** (10) sets a read of 10 bytes.

In the second response, the **RC** value (001) shows the read failed. The **ATTM** value (255) indicates 255 attempts. The **data** consists of ASCII zeros upon read operation failure.

Table 6.C
Transaction Response Return Code Values

RC Value	Meaning
001	Operation failed. Possible causes – no tag present, RF power is too low, RF signal is obstructed, antenna is failing or tag is failing.
002	Operation successful
003	Tag detected; operation failed. Possible causes – RF power level is inadequate, RF signal is obstructed, tag is too far from antenna, timeout inadequate.
009	Operation invalid, operation failed. Possible cause – tag type configuration setting is invalid for type of transaction, data not correct for tag type.
011	Tag detected, operation invalid, operation failed. Possible cause – antenna is set for programmable addressable tag type, and tag has not been previously programmed.

Write Tag Command

Command Format:
W[ritetag] [REPCNT]_address_length<SP>data<CR>

Response Format:
TNS<SP>RC<SP>ATTM<CR>

Use the Write Tag command to perform a tag write. Use the optional **REPCNT** (repeat count) field to specify the number of times the Write Tag command is repeated. The **address** field indicates the starting point of the tag write (**Note:** The antenna automatically translates the **address** values hexadecimal). The **address** must be minimum of 32 for read/write tags. The first 32 bytes are reserved for tag status information and are read only.

The **length** is the amount of consecutive bytes you write to beginning at the starting **address** (maximum length is the lesser of tag size or 226 bytes). The length must be an even number of bytes.

The antenna response includes the return code (**RC**), and **ATTM**, the number of attempts made by the antenna. Each response field (except **TNS**) has three digits. The return code (**RC**) is described in Table 6.C on page 6-8.

Example Command:
W3<SP>32<SP>8<SP>12345678<CR>

Example Response:
09<SP>002<SP>008<CR>
10<SP>001<SP>255<CR>
11<SP>002<SP>006<CR>

In the example command above, the **W3** (write tag with REPCNT 3) causes a tag write to be performed three times. The **address** value (32) starts the tag write at address 0020 (hex). The **length** value (8) sets the message length to 8 bytes, and is followed by a single space, then the **data** field (see Table 7.B, page 7-3, for amount and types of tag data allowed).

The second example response indicates a failed tag write operation. The **RC** value (001) indicates the operation failed. The **ATTM** value (255) indicates 255 attempts made.

Multiple Command

Command Formats:

Read/Read
M[ultiple] [REPCNT]_R[eadtag]_address_length_
R[eadtag]_address_length<CR>

Write/Write
M[ultiple] [REPCNT]_W[ritetag]_address_length<SP>
data_W[ritetag]_address_length<SP>data<CR>

Read/Write
M[ultiple] [REPCNT]_R[eadtag]_address_length_W[ritetag]
_address_length<SP>data<CR>

Write/Read
M[ultiple] [REPCNT]_W[ritetag]_address_length<SP>
data_R[eadtag]_address_length<CR>

Response Format:

TNS<SP>RC<SP> . . . (first Read or WriteTag response)
TNS<SP>RC<SP> . . . (second Read or WriteTag response)

Use the Multiple command to perform two consecutive read tag or write tag commands, in any of four combinations. Use any one of the four format combinations as shown above (Read/Read, Write/Write, Read/Write, or Write/Read).

For each Multiple command, the antenna returns two responses (read and/or write tag responses, depending on which commands are combined). If a **REPCNT** is included, two responses are returned for each repeat of the Multiple command. For descriptions of read or write tag responses, see "Read Tag Command," and "Write Tag Command."

Note: The amount of data you can transfer using a Multiple command combination differs slightly from the amount allowed for individual read and write commands:

- For Multiple Read/Read or Write/Write (two commands of the same type):

  The combined number of bytes in two like commands must **add up to 218** bytes or less.

- For Multiple Read/Write or Write/Read (two commands of differing type):

  Each of the two commands can have up to 218 bytes of data.

Multiple Command (continued)

Example Command 1:
M2<SP>R<SP>32<SP>8<SP>W<SP>36<SP>4<SP>1234<CR>

In example command 1 above, the **M2** (command and **REPCNT**) causes a Multiple command to be performed twice. This command uses the Multiple **Read/Write** format (see "Command Formats" in this section). After **M2**, the next three fields, **R**, **32**, and **8**, define a tag Read: **R** for Read Tag; **32 address** value (read starts at address 0020); **8 length** value sets the number of characters read at 8.

The next four fields, **W**, **36**, **4**, and **1234**, define a tag Write: **W** for Write Tag; the **address** value (**36**) starts the WRITE at address 0024 Hex (decimal value is translated to Hex by the antenna). The **length** value (**4**) sets the message length to 4 bytes. This is followed by a single space, then **data** (**1234**), the actual message bytes.

Example 1 Response:
12<SP>002<SP>001<SP>010<SP> ABCDEFGH<CR>
13<SP>002<SP>001<CR>
14<SP>002<SP>001<SP>010<SP> ABCDEFGH<CR>
15<SP>002<SP>001<CR>

The Example 1 Response consists of four responses, because the Multiple command in Example 1 is performed twice (REPCNT = 2). Since the Multiple command contains a **Read** and a **Write** command, there are two **Read** command responses (**12** and **14** above), and two **Write** command responses (**13** and **15**).

Example Command 2:
Create a Multiple **Read/Read** command which does the following:

- Perform the Multiple command three times (M3).
- READ tag starting at address 0 for 4 bytes (**R**<SP>**0**<SP>**4**).
- READ tag starting at address 2 for 4 bytes (**R**<SP>**2**<SP>**4**).

Multiple Command (continued)

Solution – Example Command 2:
M3<SP>R<SP>0<SP>4<SP>R<SP>2<SP>4<CR>

Example Command 2 response:
18<SP>002<SP>001<SP>004<SP>ABCD<CR>
19<SP>002<SP>001<SP>004<SP>CDEF<CR>
20<SP>002<SP>001<SP>004<SP>ABCD<CR>
21<SP>002<SP>001<SP>004<SP>CDEF<CR>
22<SP>002<SP>001<SP>004<SP>ABCD<CR>
23<SP>002<SP>001<SP>004<SP>CDEF<CR>

Lines 18 and 19 are the response to the first performance of the Multiple **Read/Read** command. The response patterns of 18 and 19 are repeated in response lines 20 and 21, and in lines 22 and 23, which are the responses for the second and third performances of the command, respectively.

In response 18, the returned **data** bytes (**A B C D**) are from addresses 0000, 0001, 0002, and 0003 (Read tag starting at address 0000 for 4 bytes). In response 19, the **data** (**C D E F**) is from 0002, 0003, 0004, and 0005 (Read tag starting at address 0002 for 4 bytes).

Diagnostics Command

Command Format:
D[iagnostics]<CR>

Response Format:
TNS<SP>RC<SP>idiag<SP>sdiag<CR>

Use the Diagnostics command to run diagnostics as a part of troubleshooting process for antenna performance problems.

The antenna response includes the return code (**RC**), a three-digit interface diagnostics field (**idiag**), and a three-digit sensor diagnostics field (**sdiag**).

The return codes are listed in Table 6.A on page 6-7. To determine the meaning of the **idiag** and **sdiag** values, refer to Tables 6.D, 6.E, and 6.F as follows:

1. Refer to Table 6.F, and look up the **idiag** or **sdiag** value in the **idiag/sdiag** column. Determine from the row of that value which diagnostic bits (0-5) are set (set = 1).

2. Look up the meaning of each bit that is set in Table 6.D (**idiag** values) or Table 6.E (**sdiag** values).

3. If a (000) is returned for **idiag** and **sdiag**, the diagnostics were successful for both host and sensor interface.

Diagnostics Command (continued)

Example Command:

D<CR>

Example Response:

02<SP>000<SP>001<SP>000<CR>

The **RC** value (000) indicates a successful operation. As shown in Table 6.F, the **idiag** value (001) indicates Bit 0 is set, which indicates a failure ("RAM test failed," Table 6.D). The **sdiag** value (000) indicates all sensor diagnostics tests were successful.

Table 6.D
Interface Diagnostics (idiag) Bit Meanings

Bit Set	Meaning
0	RAM test failed
1	EPROM test failed
2	Always 0
3	Always 0
4	Sensor communications test failed
5	Always 0

Table 6.E
Sensor Diagnostics (sdiag) Bit Meanings

Bit Set	Meaning
0	RAM test failed
1	EPROM test failed
2	EEPROM test failed
3	Decoder RAM test failed
4	Decoder ROM test failed
5	Decoder test failed

Diagnostics Command
(continued)

Table 6.F
Diagnostic Field Value Conversions for Interface and Sensor Diagnostics (idiag and sdiag)

idiag/ sdiag	Diagnostic Bits Set (1 = Set)						Hex Value	idiag/ sdiag	Diagnostic Bits Set (1 = Set)						Hex Value
	5	4	3	2	1	0			5	4	3	2	1	0	
000	0	0	0	0	0	0	00	032	1	0	0	0	0	0	20
001	0	0	0	0	0	1	01	033	1	0	0	0	0	1	21
002	0	0	0	0	1	0	02	034	1	0	0	0	1	0	22
003	0	0	0	0	1	1	03	035	1	0	0	0	1	1	23
004	0	0	0	1	0	0	04	036	1	0	0	1	0	0	24
005	0	0	0	1	0	1	05	037	1	0	0	1	0	1	25
006	0	0	0	1	1	0	06	038	1	0	0	1	1	0	26
007	0	0	0	1	1	1	07	039	1	0	0	1	1	1	27
008	0	0	1	0	0	0	08	040	1	0	1	0	0	0	28
009	0	0	1	0	0	1	09	041	1	0	1	0	0	1	29
010	0	0	1	0	1	0	0A	042	1	0	1	0	1	0	2A
011	0	0	1	0	1	1	0B	043	1	0	1	0	1	1	2B
012	0	0	1	1	0	0	0C	044	1	0	1	1	0	0	2C
013	0	0	1	1	0	1	0D	045	1	0	1	1	0	1	2D
014	0	0	1	1	1	0	0E	046	1	0	1	1	1	0	2E
015	0	0	1	1	1	1	0F	047	1	0	1	1	1	1	2F
016	0	1	0	0	0	0	10	048	1	1	0	0	0	0	30
017	0	1	0	0	0	1	11	049	1	1	0	0	0	1	31
018	0	1	0	0	1	0	12	050	1	1	0	0	1	0	32
019	0	1	0	0	1	1	13	051	1	1	0	0	1	1	33
020	0	1	0	1	0	0	14	052	1	1	0	1	0	0	34
021	0	1	0	1	0	1	15	053	1	1	0	1	0	1	35
022	0	1	0	1	1	0	16	054	1	1	0	1	1	0	36
023	0	1	0	1	1	1	17	055	1	1	0	1	1	1	37
024	0	1	1	0	0	0	18	056	1	1	1	0	0	0	38
025	0	1	1	0	0	1	19	057	1	1	1	0	0	1	39
026	0	1	1	0	1	0	1A	058	1	1	1	0	1	0	3A
027	0	1	1	0	1	1	1B	059	1	1	1	0	1	1	3B
028	0	1	1	1	0	0	1C	060	1	1	1	1	0	0	3C
029	0	1	1	1	0	1	1D	061	1	1	1	1	0	1	3D
030	0	1	1	1	1	0	1E	062	1	1	1	1	1	0	3E
031	0	1	1	1	1	1	1F	063	1	1	1	1	1	1	3F

Chapter 7 Antenna Configuration and Operation

Chapter Objectives

This chapter explains how to use IDP commands to configure the antenna for types of different operation, and to perform tag transactions (read, write, and program tags). Separate sections tell how to set the antenna for:

- Using the object detect device and timeout settings
- Operation with read/write tags.
- Read/only transactions with programmable tags.
- Programming programmable tags.

Set Antenna Configuration

Before performing any tag transactions with the antenna, you first define the antenna operations. You do this by sending the Set Sensor Configuration Command from the system host, which sets the antenna for:

Tag Type – Set according to the type of tag you are using.

Object Detect Mode – Enabled or disable, according to whether or not you use an object detect device.

Transaction Timeout – Set according to requirements (**Note:** Minimum of 3 seconds for programming tags).

RF Field Strength Level – Set according to your application requirements (see Chapter 4).

Table 7.A, page 7-2, summarizes the different types of antenna operations, as defined by the use of object detect, timeout, and command repeat count.

Setting the Object Detect Mode and Timeout

Object Detect – If you are using an object detect device, you must enable the object detect mode; the object detect active signal (switch closure) will trigger transaction attempts.

Timeout – You can set a specific timeout, or set the timeout to 0. Setting the timeout to 0 disables the timeout. The antenna will keep transmitting until successful.

If you set a specific timeout when you configure the antenna, the antenna keeps attempting communication until either the tag transaction is successful, or the timeout expires.

Setting the Object Detect Mode and Timeout *(continued)*

If a timeout is set, once the object detect input occurs the antenna remains active until either the transaction succeeds, or the timeout expires, *whether or not the object detect signal actually remains activated in the interim.*

Note: The object detect device must be active for a minimum of 10 milliseconds.

Table 7.A
Antenna Operating Modes

Object Detect Mode	Timeout Setting	Repeat Count	Operation
Object Detect Enabled	0	0-255①	After receiving transaction command, and the object detect input activates, the antenna will attempt transactions until successful, or until the object detect input deactivates. Type of failure (if any) is reported to host. Repeat count decrements. Sequence repeats when the object detect input activates again, unless repeat count has expired.
Object Detect Enabled	1-65,535 (x 100 milliseconds)	0-255①	After receiving transaction command, and the object detect input activates, the antenna will attempt transactions until successful, or until the timeout expires. Type of failure (if any) is reported to host. Repeat count decrements. Sequence repeats when the object detect activates again (after timeout expires), unless repeat count expired.
Object Detect Disabled	0	0-255①	After receiving transaction command, the antenna will immediately attempt transactions until successful. No failures are reported to host. Repeat count decrements. Sequence repeats as soon as the transaction succeeds, unless repeat count has expired.
Object Detect Disabled	1-65,535 (x 100 milliseconds)	0-255①	After receiving transaction command, the antenna will immediately attempt transactions until successful, or until the timeout expires. Type of failure (if any) is reported to host. Repeat count decrements. Sequence repeats as soon as the timeout expires, unless repeat count has expired.

① Repeat count of 0 selects unlimited repeat (i.e., repeat until another command is received by the antenna).

IDP Perform Command

To read or write to the tags or program tags when using DF1 protocol, you use the IDP "Perform" command. The Perform command includes a data field in which you place a "Sensor Program." The Sensor Program contains the actual coding of the read and/or write command descriptors.

You can code a single tag read or write transaction, or chain a number of tag reads and/or writes to be executed within each tag transaction (**Note:** The complete set of IDP commands is discussed in Chapter 8. The Perform command and Sensor Program are discussed on pages 8-20 to 8-26).

Repeat Counts

The IDP Perform command includes a repeat count field, which allows you to repeat the given command a specified or an unlimited number of times. If you use a command repeat count of **0**, the command is repeated without limit (until another command is received).

We recommend that you use the object detect device and a transaction timeout when using a repeat count. This allows a more positive control over transactions, and helps curb the possibility of repeating a transaction with the same tag.

Object Detect with Timeout and Repeat Count – If you use a repeat count with object detect and a timeout, a transaction is repeated when: 1) the previous transaction succeeds or times out, 2) the object detect input goes inactive, and 3) the object detect input goes active again (after the previous transaction succeeds or times out).

Start Address and Length Fields

The transaction commands each include a start address and a length field. These fields allow you to specify which tag memory locations you will access, and how much data you will transfer (see Table 7.B for tag capabilities).

Data Limitations – The Sensor Program portion of the Perform command can be 6144 bytes long. However, if the Perform Command, including the Sensor Program, surpasses 242 bytes, you will exceed the capacity of the normal *Unprotected Write Command* data field. You would need to use the *Large Message Transfer Mode* of the *Unprotected Write Command* (see page 8-40).

Table 7.B
Tag Types and Descriptions

Tag Types	Features Summary
Read/Write①	Data can be read from or written to tag online during system operation • Any binary pattern, including all ASCII characters, can be stored. • Addressable 2k or 8k bytes of RAM memory (depending on model). • First 32 bytes are reserved, and are read only • Capable of selective, highly defined memory storage, interactive read/write exchanges, and tag data modification online.
Programmable①	Online operations with this tag normally are read only. • Depending on how the antenna is configured, the tag memory is: – 6-digit (using digits 0-9 only), or – 20 characters ②, or – 40 characters ② • Tag EEPROM memory requires initial programming (offline programming, while tag is stationary, is recommended).

①**Note:** See Publication No. 2750-2.9, "Bulletin 2750-Radio Frequency Tags," for more tag information.
②**Note:** Characters available are a subset of ASCII: 0-9, upper case A-Z, also &, *, –, and space.

Programmable Tag Transactions

To use the programmable tags for operation with your antenna, you first set the antenna configuration. You can program the programmable tags only if you use a 2750-ASP, -ASPF, -ASPR, or -ASPRF antenna. You can program tags in 6-digit, 20-character, or 40-character format. You can read programmable tags with any model antenna.

Example Programming Configuration

Assume that you are using programmable tags, and a Catalog No. 2750-ASP antenna. You want to program 40-character tags, so you will configure the antenna for 40-character programmable tag type.

When you program tags, the antenna-to-tag distance must be 5-7 inches. **Note: The tags should be stationary during programming.** Assume the object detect is used. The RF level setting does not matter; the antenna transmits at a fixed level when configured for programming.

Note: Set at least a 3-second timeout for programming tags.

In order to program tags as described above, you could set the antenna configuration as follows:

Tag Type – 40-character programmable (Word 05 = 00 22)

Object Detect Mode – Enabled (Word 07 = 00 01)

Timeout – 3 seconds (Word 08 = 00 1E)

RF Field Strength Level – Low (Word 09 = 00 02)

Example Command Format

Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
Command – (reserved)	**00**	07	(00)	00	(01)
(reserved)	**01**	00	(02)	00	(03)
Seq. No. (MSB-LSB)	**02**	00	(04)	01	(05)
Sensor No.	**03**	00	(06)	00	(07)
Reserved	**04**	00	(08)	00	(09)
Tag Type	**05**	00	(0A)	22	(0B)
(Read Only)	**06**	00	(0C)	00	(0D)
Object Detect Enable	**07**	00	(0E)	01	(0F)
Transaction Timeout	**08**	00	(10)	1E	(11)
RF Field Strength	**09**	00	(12)	02	(13)

Refer to Table 8.H, page 9-17, for coding of sensor parameters

Example Programming (Write) Command

Shown below is a Perform (write) command which can be can be used for programming programmable tags. The example command calls for the antenna to write 40 bytes of data to the tag, starting at address 0000.

Note: You must program all 40 bytes of tag memory, unless you set the antenna for a programmable, addressable tag type (see "Addressable Programming" below).

With the antenna set for a 3-second timeout, object detect enabled, the antenna attempts to complete the transaction when the object detect signal goes active.

Write descriptor

Example Command Format					
Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
Command – Repeat Ct.	**00**	08	(00)	01	(01)
(reserved)	**01**	00	(02)	00	(03)
Seq No. (MSB-LSB)	**02**	00	(04)	02	(05)
Sensor No.	**03**	00	(06)	00	(07)
Write with no more (08) Reserved (09)	**04**	01	(08)	00	(09)
Reserved	**05**	00	(0A)	00	(0B)
Start Addr. (MSB-LSB)	**06**	00	(0C)	00	(0D)
Length (MSB-LSB)	**07**	00	(0E)	28	(0F)
Data (ASCII A,1)	**08**	41	(10)	11	(11)
Data (ASCII B,2)	**09**	42	(12)	12	(13)
... ...	... ...		... ...		... ...
Data (ASCII 9, 9)	**1B**	19	(36)	19	(37)

Addressable Programming

To program tags and access specific tag memory locations, you must configure the antenna tag type for *programmable addressable* (6-digit, 20-character, or 40-character).

Note: Before you can program a tag using an antenna configured for the *programmable, addressable* tag type, you must first program all of the tag's memory (6-digit, or 20- or 40-character) with the antenna configured for *programmable* tag type.

Example Read Only Configuration

Assume that you are using programmable tags, and a Catalog No. 2750-ASD Short Range Antenna. You want to execute a repeating tag read command (**Note:** You can read programmable tags with any model antenna).

Assume the antenna-to-tag distance is 8 inches (61 cm). The tags are stationary during transactions, stopping for 10 seconds in the antenna signal range. You are using an object detect device.

In order to operate the antenna as described above, you must configure antenna for 6-digit, 20-character, or 40-character read only. Set the following configuration parameters as a starting point (the timeout and RF level settings might require adjustment as you test the operation):

Tag Type – Read Only (Word Offset 05 = 00 00)

Object Detect Mode – Enabled (Word Offset 07 = 00 01)

Timeout – 3 seconds (Word Offset 08 = 00 1E)

RF Field Strength Level – High (Word Offset 09 = 00 05)

The diagram below is a Set Sensor Configuration command which could be used for setting the above parameters:

Refer to Table 8.H, page 9-17, for coding of sensor parameters (applies to rows Reserved through RF Field Strength)

Example Command Format					
Command Field(s)	**Word Offset**		**(Byte Offset)**		**(Byte Offset)**
Command – (reserved)	**00**	07	(00)	00	(01)
(reserved)	**01**	00	(02)	00	(03)
Seq. No. (MSB-LSB)	**02**	00	(04)	03	(05)
Sensor No.	**03**	00	(06)	00	(07)
Reserved	**04**	00	(08)	00	(09)
Tag Type	**05**	00	(0A)	00	(0B)
(Read Only)	**06**	00	(0C)	00	(0D)
Object Detect Enable	**07**	00	(0E)	01	'(0F)
Transaction Timeout	**08**	00	(10)	1E	(11)
RF Field Strength	**09**	00	(12)	05	(13)

Example Repeating Read Command

Shown below is a Perform (read) command, which includes a repeat count set to 00 (unlimited repeats).

The command calls for the antenna to read 40 bytes of data. The read starting address is 0000 Hex. The length is 0028 Hex (40 decimal). The read descriptor includes a 40-byte data buffer.

When you send the repeating read command (with the antenna configured for object detect enabled and a 3-second timeout) the antenna will transmit when the object detect goes active. The antenna will continue to transmit until successful, or until the timeout expires. The antenna will repeat the read when the object detect goes active again.

Read descriptor

Example Command Format

Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
Command – Repeat Ct.	**00**	08	(00)	00	(01)
(reserved)	**01**	00	(02)	00	(03)
Seq No. (MSB-LSB)	**02**	00	(04)	04	(05)
Sensor No.	**03**	00	(06)	00	(07)
Read with no more (08) Reserved (09)	**04**	00	(08)	00	(09)
Reserved	**05**	00	(0A)	00	(0B)
Start Addr. (MSB-LSB)	**06**	00	(0C)	00	(0D)
Length (MSB-LSB)	**07**	00	(0E)	28	(0F)
Data (2 ASCII spaces)	**08**	20	(10)	20	(11)
Data (2 ASCII spaces)	**09**	20	(12)	20	(13)
... ...	... ...		... ...		... ...
Data (2 ASCII spaces)	**1B**	20	(36)	20	(37)

Read/Write Tag Transaction

To use the read/write tags for operation with your antenna, you first set the antenna configuration for your operation.

Example Configuration

Assume that you are using read/write tags, and a Catalog No. 2750-AS antenna. You are using an object detect device.

Assume the antenna-to-tag distance is 24 inches (61 cm). The tags are moving during transactions, at a speed of 12 inches (30 cm) per second. This means the tags are in the antenna signal range for about 2 seconds.

In order to operate the antenna in the conditions described above, you might set the following configuration parameters as a starting point (the timeout and RF level settings might require adjustment as you test the operation):

Tag Type – 2K read/write tag (Word Offset 05 = 00 10)

Object Detect Mode – Enabled (Word Offset 07 = 00 01)

Timeout* – 2 seconds (Word Offset 08 = 00 14)

RF Field Strength Level – High (Word Offset 09 = 00 05)

***Note:** Set timeout to accommodate transaction. This may require some testing and simulation. Large data transfers, or chained transactions, require a longer timeout than a single transaction with 30 bytes of data, for example.

Example Command Format

Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
(reserved) – Command	**00**	07	(00)	00	(01)
(reserved)	**01**	00	(02)	00	(03)
Seq. No. (MSB-LSB)	**02**	00	(04)	05	(05)
Sensor No.	**03**	00	(06)	00	(07)
Reserved	**04**	00	(08)	00	(09)
Tag Type	**05**	00	(0A)	10	(0B)
(Read Only)	**06**	00	(0C)	00	(0D)
Object Detect Enable	**07**	00	(0E)	01	(0F)
Transaction Timeout	**08**	00	(10)	14	(11)
RF Field Strength	**09**	00	(12)	05	(13)

Refer to Table 8.H, page 9-17, for coding of sensor parameters

Example Perform (Read/Write) Command

Shown below is an example Perform (read/write) command. This command includes a tag read chained to a tag write, which would normally be used only with a read/write tag.

The command calls for the antenna to first read 4 bytes of data. The read starting address is 0020 Hex (32 decimal). The read descriptor includes a 4-byte data buffer. The antenna would then write 4 bytes of data to the tag, starting at address 0022 (34 decimal).

With the antenna set for a 2-second timeout, object detect enabled, the antenna attempts to complete the transaction when the object detect signal goes active.

Example Command Format

	Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
	Command – Repeat Ct.	**00**	08	(00)	01	(01)
	(reserved)	**01**	00	(02)	00	(03)
	Seq No. (MSB-LSB)	**02**	00	(04)	06	(05)
	Sensor No.	**03**	00	(06)	00	(07)
Start of 1st descriptor (**Read** with more to follow)	Read with more (08) Reserved (09)	**04**	80	(08)	00	(09)
	Reserved	**05**	00	(0A)	00	(0B)
	Start Addr. (MSB-LSB)	**06**	00	(0C)	20	(0D)
	Length (MSB-LSB)	**07**	00	(0E)	04	(0F)
	Data (ASCII spaces)	**08**	20	(10)	20	(11)
	Data (ASCII spaces)	**09**	20	(12)	20	(13)
Start of 2nd descriptor (**Write** with none to follow)	Write, none to follow (14) Reserved (15)	**0A**	01	(14)	00	(15)
	Reserved	**0B**	00	(16)	00	(17)
	Start Addr (MSB-LSB)	**0C**	00	(18)	22	(19)
	Length (MSB-LSB)	**0D**	00	(1A)	04	(1B)
	Data (ASCII A, B)	**0E**	41	(1C)	42	(1D)
	Data (ASCII C, D)	**0F**	43	(1E)	44	(1F)

Chapter 8 Developing DF1 Protocol

Chapter Objectives

This chapter defines the basic elements of the Allen-Bradley DF1/PCCC/IDP communication protocol, or DF1 protocol. DF1 protocol is used to communicate with and operate the 2750-AS series antennas. Read this chapter for guidelines in developing a host program for transmitting and receiving serial antenna messages. This chapter includes:

- Overview of the DF1 protocol.
- Description of DF1 layer format, attributes, and programming requirements.
- Description of the Programmable Controller Command Codes (PCCC), or "network" structure.
- Description of the "application" programming required, which initiates commands and responses.

Note: In communication between a host computer and serial antenna, there are actually two independent protocol subsystems: 1) the **host transmitting** – antenna receiving subsystem; 2) antenna transmitting – and **host receiving** subsystem. This chapter discusses the DF1 protocol with emphasis on the **host** programming side, including the host transmitting and receiving formats and routines.

Overview – Transmitter and Receiver Functions

The host has both transmitter and receiver functions (see Figure 8.1). The host transmitter function includes:

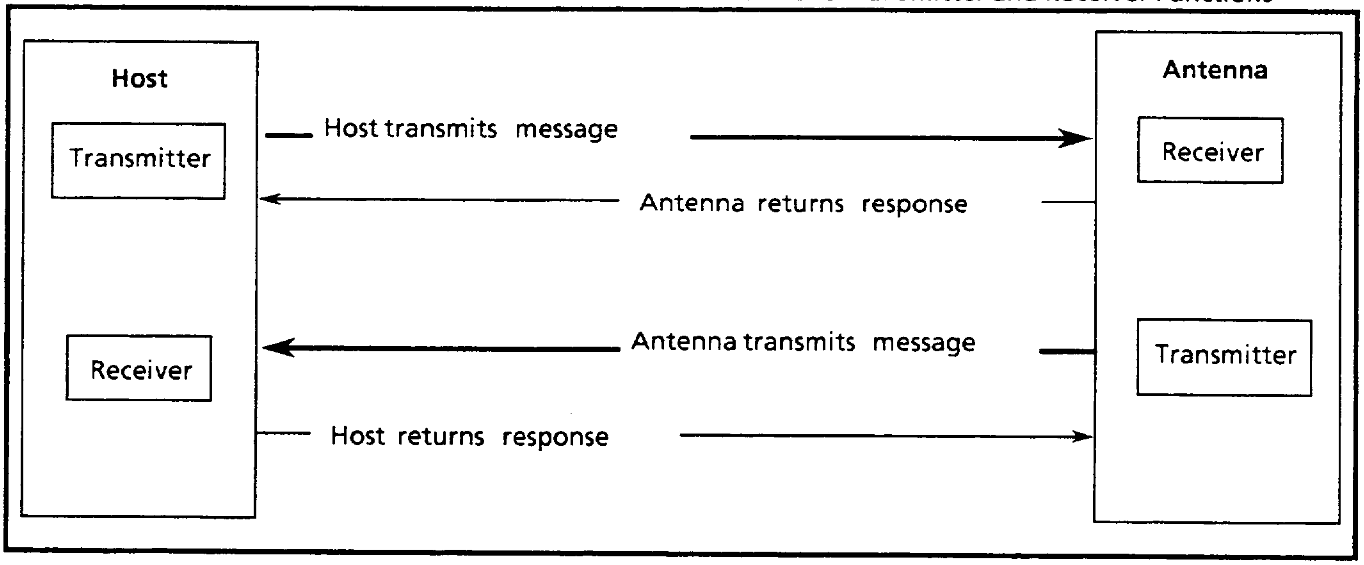
- Transmitting data, using defined transmission codes and data verification.
- Awaiting and receiving acknowledgment from receiver.
- Requesting acknowledgment if none is received.
- Retransmitting if negative acknowledgment received.

The host receiver function includes:

- Receiving message, and verifying data.
- Transmitting message acknowledgement.
- Resending acknowledgement if requested by transmitter.

Overview – Transmitter and Receiver Functions *(continued)*

Figure 8.1
Host and Antenna Each Have Transmitter and Receiver Functions



Overview of DF1 Protocol

DF1 protocol is a scheme developed to enable reliable sensor operation by a remote host computer over serial communication lines.

The term "DF1 protocol" refers to a combination of three separate layers. Each protocol "layer" is discussed separately in this chapter. These layers are listed and described briefly below (see Figure 8.3):

DF1 – The data link layer of DF1 protocol. You use DF1 protocol to transmit data (containing IDP and/or network commands) over a serial communication link.

PCCC ("Network") – The network layer consists of command and response formats for handling communications between the host application program and the antenna. The network commands and responses are inserted as data within the DF1 layer.

IDP (Identification Protocol) – IDP consists of the command/response coding defined for the antenna. Your host application program operates the antenna by issuing IDP commands to the antenna, and handling IDP responses from the antenna. The IDP commands are placed in the network level format, and inserted into DF1 format data field for transmission.

Typical DF1 Protocol Communication Sequence

A typical antenna command sequence in DF1 protocol consists of four command and response pairs. These include both DF1 and network commands and responses. Of these four pairs, two involve the command to the antenna, and two involve the response from the antenna.

The DF1 communication sequence is described below, and is illustrated in Figure 8.2:

A. Host initiates communication, sending a command to the antenna:

1. a. The host transmits a message to antenna in DF1 (link layer) format. Within the **DF1** format is a data field containing the **network** command; within the network command format is a data field containing the **antenna (IDP)** command (see Fig. 8.3 for message format).

   b. The antenna transmits link layer response (**"ACK"**) to acknowledge received message.

2. a. The antenna transmits a **network** response (to the **network** command in step 1) to acknowledge received network command.

   b. The host transmits link layer response (**"ACK"**) to acknowledge the received network command.

B. After executing the command, the antenna initiates communication with the host:

3. a. The antenna transmits a **DF1** message; within the data field is a **network** command; within the network command format is a data field which contains the **antenna (IDP)** response (to the IDP command in step 1.a.).

   b. The host transmits link layer response (**"ACK"**)to acknowledge received network command.

4. a. The host transmits a **network** response (to the **network** command in step 3).

   b. The antenna transmits link layer response (**"ACK"**).

Note: The network level responses (Steps 2.a and 4.a above) can be disabled (see "DF1 responses disabled" under the "Options" byte Table 8.G, page 8-13, and page 8-14).

Typical DF1 Protocol Communication Sequence *(continued)*

Figure 8.2
Typical DF1/IDP Host / Antenna Command Exchange

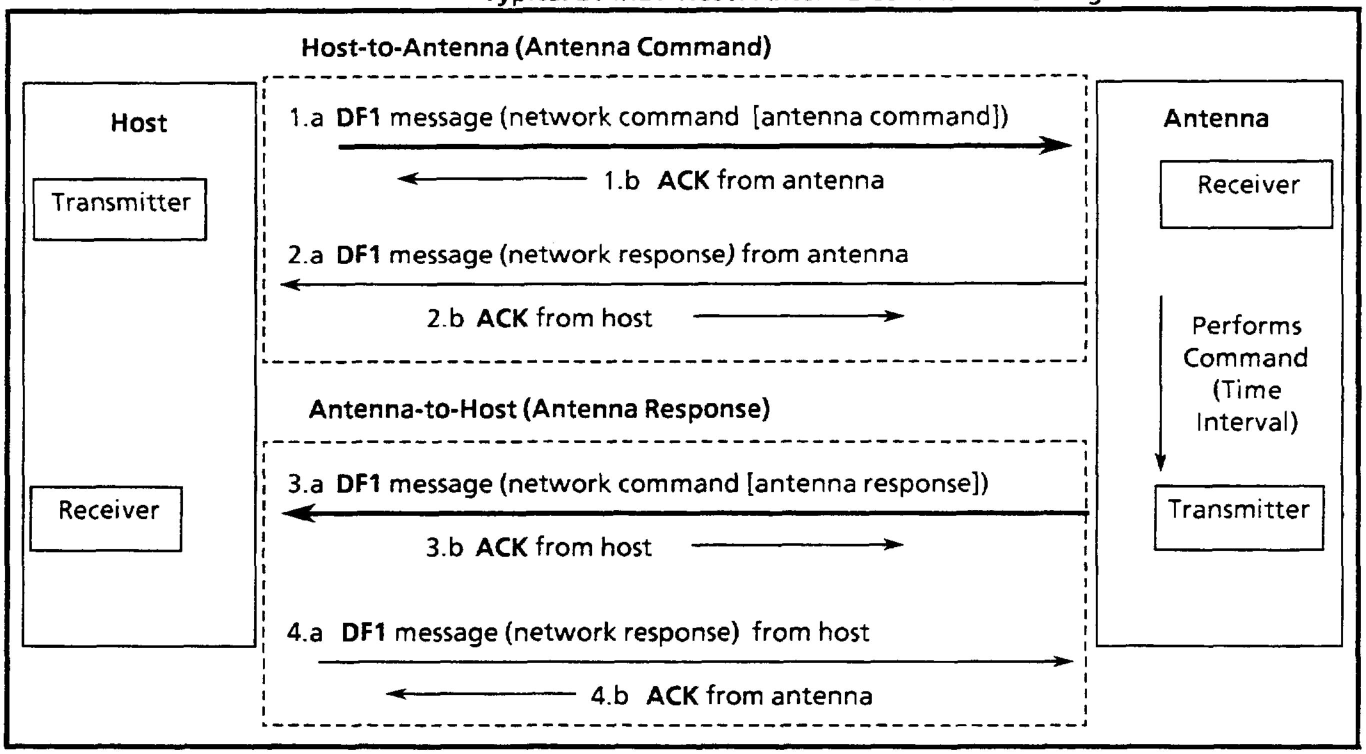
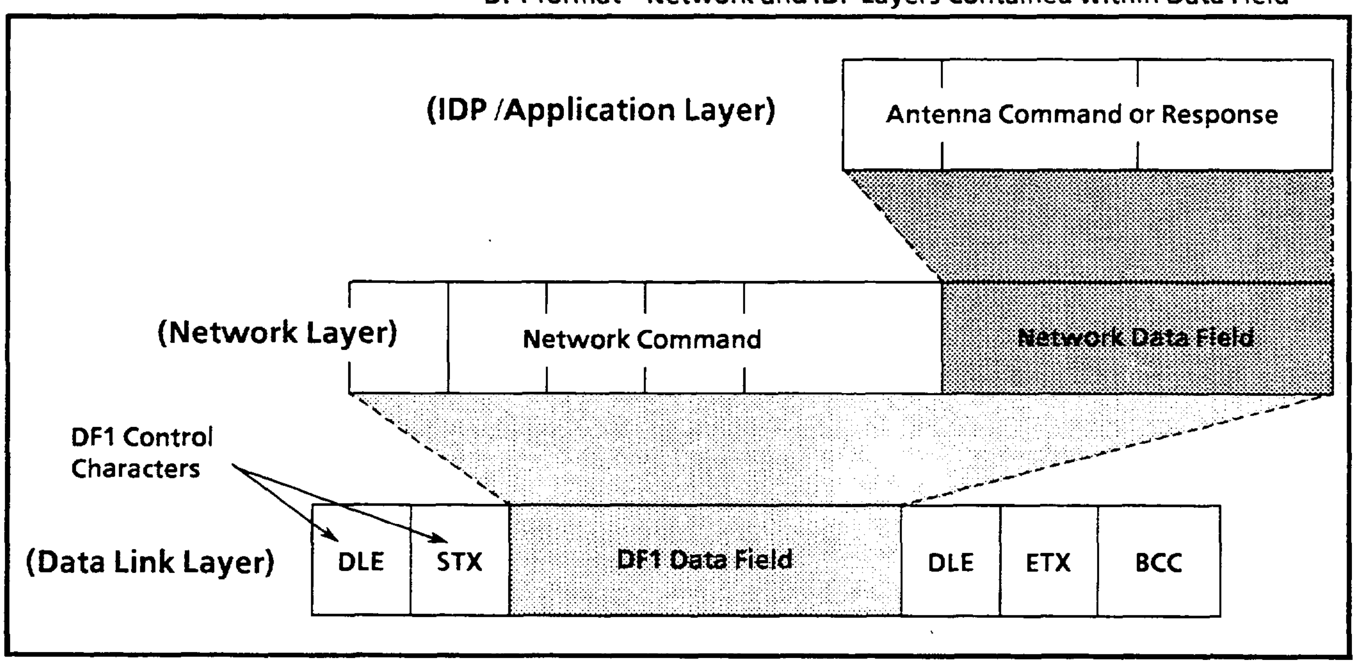


Figure 8.3
DF1 format – Network and IDP Layers Contained within Data Field



DF1 Overview

DF1 is the data link layer protocol which transmits data between antenna and host.

DF1, as used with the antennas, can be described as full-duplex, peer-to-peer communication. DF1 consists of the following:

- Two stations (i.e., host and antenna) which exchange messages. Each station functions as both a transmitter and receiver.
- A defined message format, consisting of control characters, with defined sequences (codes) for transmitting messages and acknowledging messages.
- Routines for transmitting, receiving, and acknowledging messages, with retries, and retransmission requests.
- Optional data verification.

Note: For information describing the communication standards comprising DF1 protocol, refer to publication ANSI X3.28–1976, and compare DF1 to ANSI subcategories D1 and F1. DF1 combines selected attributes from each subcategory – D1 (data transparency and control characters), and F1 (two-way simultaneous transmission, with host and antenna each capable of acting as master or slave, and with a block check character).

DF1 Message Format

The DF1 message format consists simply of control characters and data, with defined character sequences (codes) for transmitting and acknowledging messages.

(DLE)	(STX)	(Data Field)							(DLE)	(ETX)	(BCC)
10	02	08	09	06	00	02	04	03	10	03	FE

Control Characters

Control characters are the "building blocks" of DF1 messages. Listed below are all the control characters (with corresponding Hex values) used in DF1 transmissions:

Table 8.A
DF1 Control Characters

Character Mnemonic	Hex Value	Meaning
DLE	10	Data Link Escape (prefix)
STX	02	Start of Text
ETX	03	End of Text
ENQ	05	Enquiry
ACK	06	Acknowledge
NAK	15	Negative Acknowledge

Data Field

The data field of a DF1 message is used to carry network and antenna commands (see Figure 8.3). Data can be any value (00-FF), except 10 Hex, which requires special handling:

> To encode the data value 10 Hex, use two consecutive 10 Hex bytes; this is to distinguish 10 Hex as data from the control character **DLE**, which is encoded 10 Hex.

Notes:

(1) The DF1 data field is 250 characters maximum (see also page 8-40 regarding large message transfer).

(2) The minimum size of a valid network message is 6 bytes.

Transmission Codes

The control characters used in DF1 are grouped into five sequences called **transmission codes**, each with a specific meaning to the receiver (see Table 8.B). The code characters are sent in sequence, with no bytes between the characters.

DLE (10 Hex) prefix begins all DF1 transmission codes, followed by other control characters, as shown in Table 8.B:

Table 8.B
DF1 Transmission Codes

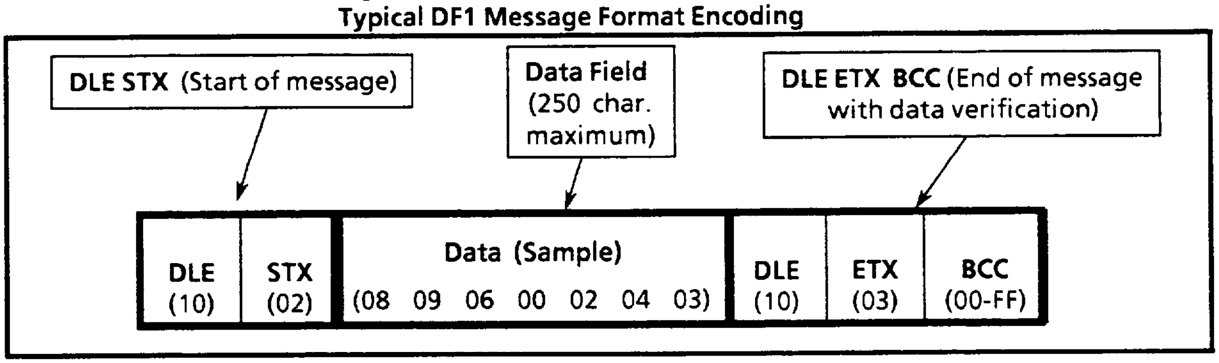
Message Source	DF1 Codes	Hex Code	Code Meaning
Transmitter	DLE STX	10 02	Start of DF1 data transmission
	DLE ETX BCC*	10 03 (00-FF)	End of DF1 data transmission
	DLE ENQ	10 05	Enquiry
Receiver	DLE ACK	10 06	Acknowledge – received message
	DLE NAK	10 15	Negative Acknowledge

*Note: **BCC** is an optional block check character, appended to the DF1 message for data error checking (see "Block Check Character" in this section).

Typical DF1 Message Example

The DF1 message format consists of defined DF1 transmission codes which envelope a data field. The codes and fields are formatted as shown in Figure 8.4).

Figure 8.4
Typical DF1 Message Format Encoding



DF1 message field descriptions (see Figure 8.4):

DLE STX – signals start of DF1 message with data field.

Data Field – Data field follows **DLE STX**; contains the network command or response (including antenna command or response, if applicable).

Typical DF1 Message Example (continued)

DLE ETX BCC – placed at end of the data field, and terminates the DF1 transmitter message. The **BCC** is optional for data verification.

DLE ENQ (not shown) – tells receiver to resend **DLE ACK** or **DLE NAK.** The **DLE ENQ** is sent by the transmitter when the ACK or NAK from the receiver has not been received after a message has been transmitted; **DLE ENQ** requests the retransmission of the last transmission from the receiver (either a **DLE ACK** or a **DLE NAK**).

DF1 Responses

The receiver sends **DLE ACK** or **DLE NAK** responses to each DF1 message received.

DLE ACK – sent by the receiver when the receiver has successfully received the last message sent. The transmitter can then send another message, or end transmission.

DLE NAK – sent by the receiver to indicate the receiver did not successfully receive the last message sent, and requests the retransmission of the last message from the transmitter.

Block Check Character (BCC)

The block check character (**BCC**) field is used to verify the correct reception of the data bytes within a received DF1 transmission. The **BCC** is the "twos complement" of the sum of values in the DF1 data field (sum of all bytes after **DLE STX**, and before **DLE ETX BCC**, overflow discarded). In DF1 protocol, the BCC value is derived and appended by the transmitter of a DF1 message (see "The DF1 Transmitter" this section); the receiver derives a **BCC** when receiving the DF1 data, and compares this to the **BCC** value supplied by the transmitter.

The **BCC** provides data security. It cannot detect transposition of bytes during transmission of a message. It also cannot detect the insertion or deletion of zeros (0) within a data field (see Appendix B to calculate the two's complement BCC value).

Note: Use of the BCC is optional and can be disabled. See Table 9.G, page 9-13.

Developing the DF1 Transmitter/Receiver Routines

Using DF1 protocol involves not only the formats described above, but also the necessary transmitter/receiver programming, or DF1 "driver."

On a two-way simultaneous data link, such as that between the host computer and serial antenna, there are actually two independent, symmetrical protocol subsystems involving (1) the **host transmitting**/antenna receiving, and (2) antenna transmitting/**host receiving**. This section discusses the host transmitter, and host receiver routines specifically.

This section describes the required components of a typical host DF1 driver, and includes the following:

- Transmitter Overview
- Receiver Overview
- Multiplexing and Separating Messages
- Protocol Environment
- DF1 Transmitter
- DF1 Receiver
- Embedded Responses
- Full-duplex Protocol Examples (illustrations)

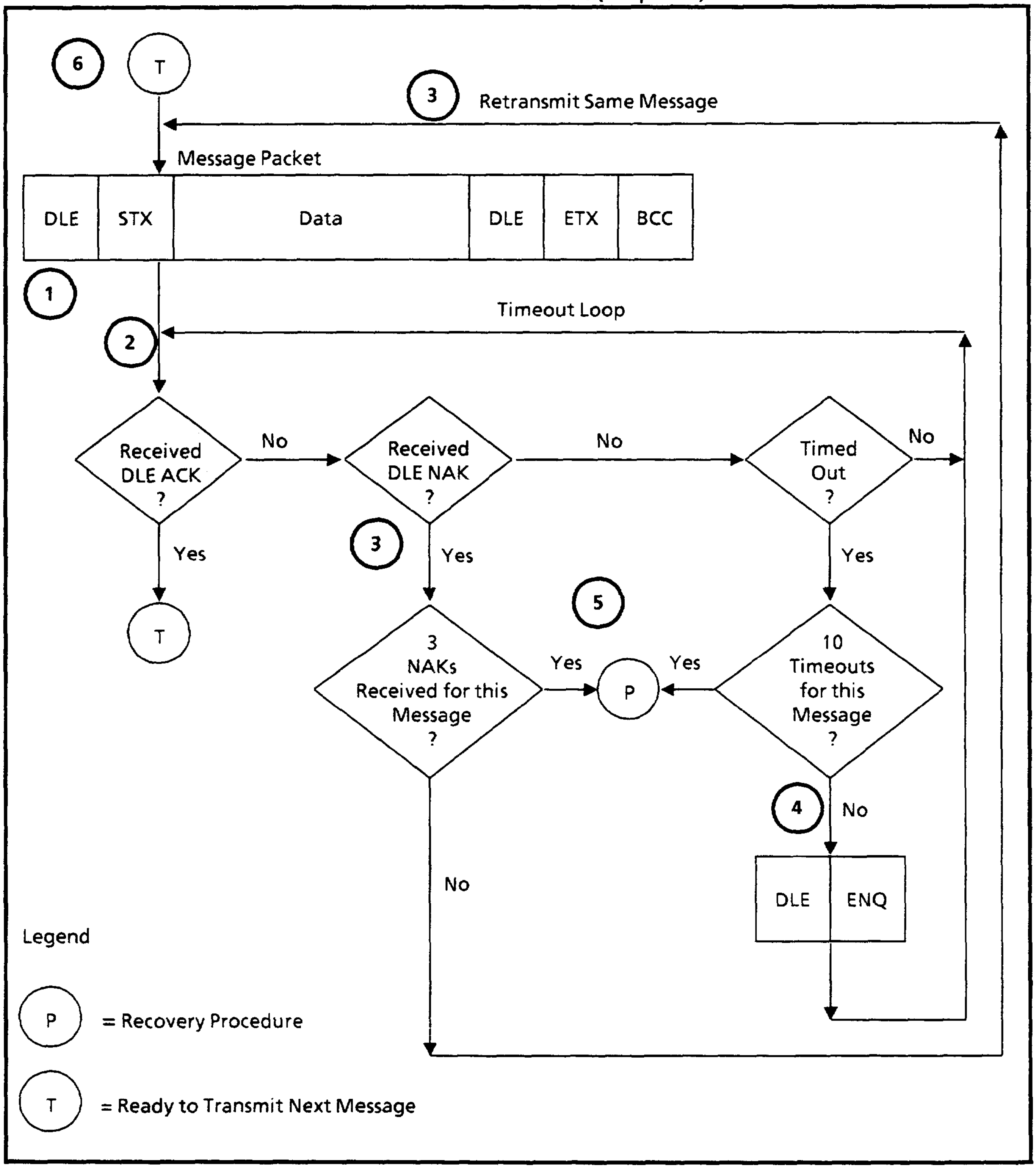
Transmitter Overview

The DF1 transmitter does the following (see Figure 8.5 for transmitter diagram):

1. Transmits data, incorporating defined transmission codes and data verification.
2. Begins a counter and waits for Ack from receiver.
3. Retransmits the original message if Nak received.
4. Sends Enquiry if timed out with no response.
5. Goes to a recovery procedure if timeout or Nak limit exceeded.
6. If Ack received, ready to transmit new message.

Transmitter Overview
(continued)

Figure 8.5
DF1 Transmitter Routine (Simplified)



Receiver Overview

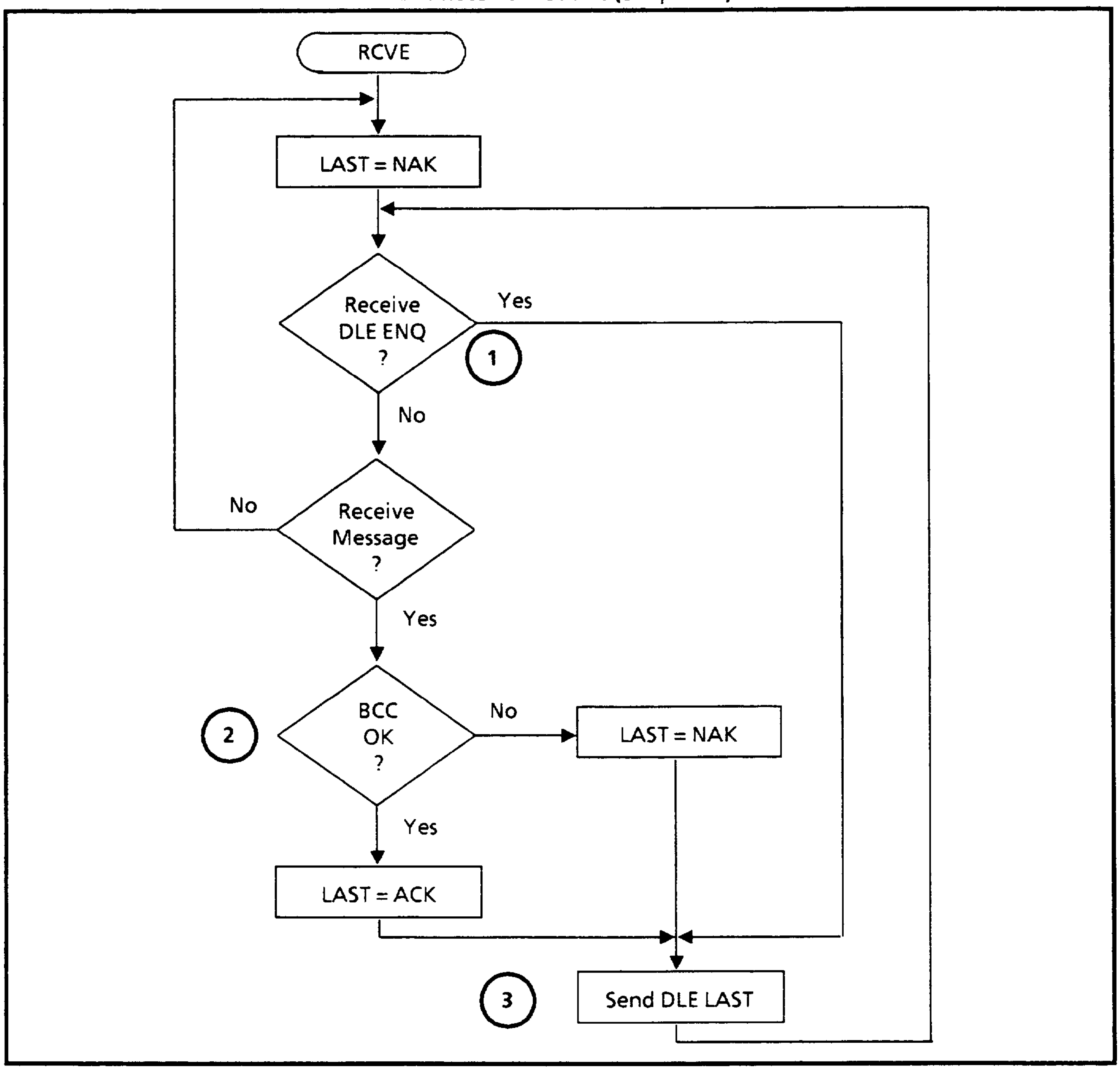
The host DF1 receiver (see Figure 8.6 for receiver diagram):

1. Waits to receive either an enquiry or message. If an enquiry received, resends last Ack or Nak.

2. If message received, verifies data (BCC).

3. If data verified, sends Ack. If not, sends Nak.

Figure 8.6
DF1 Receiver Routine (Simplified)



Multiplexing and Separating Messages

As shown in Figure 8.7, there are four data paths in host/antenna communications:

Host Transmitter sends DF1 message to **Antenna Receiver** on **Path 1**.

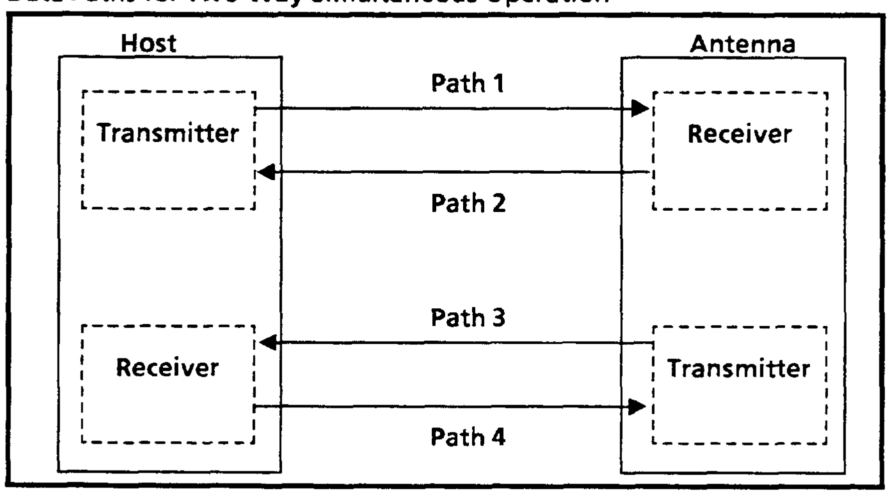
Antenna Receiver returns response code to **Host Transmitter** on **Path 2**.

Antenna Transmitter sends DF1 message to **Host Receiver** on **Path 3**.

Host Receiver returns response code to **Antenna Transmitter** on **Path 4**.

With only two physical circuits in use, implementation of DF1 requires **multiplexing** of the host's outgoing transmitter messages and receiver responses (**Paths 1** and **4** in Figure 8.7).

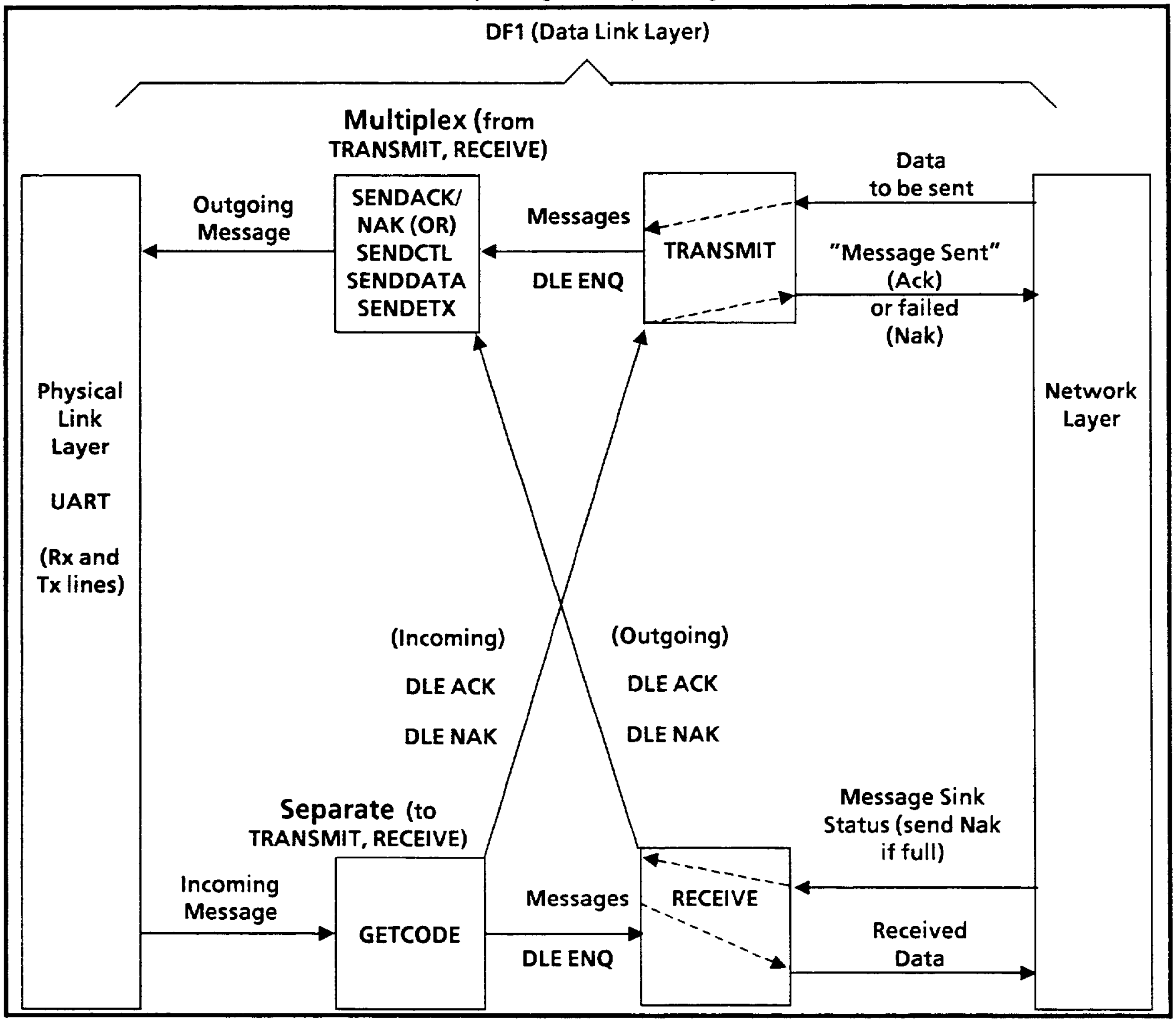
Figure 8.7
Data Paths for Two-Way Simultaneous Operation



Multiplexing and Separating Messages (continued)

Also required is **separating** and routing of the incoming messages and responses– data fields to the receiver routine, and the response codes to the transmitter routine (**Paths 2** and **3** in Figure 8.7).

Figure 8.8
Multiplexing and Separating Transmitter and Receiver Messages



The multiplexer and separator functions are incorporated in the descriptions in the "DF1 Transmitter" and "DF1 Receiver" sections. Figure 8.8 illustrates the multiplexer and separator functions.

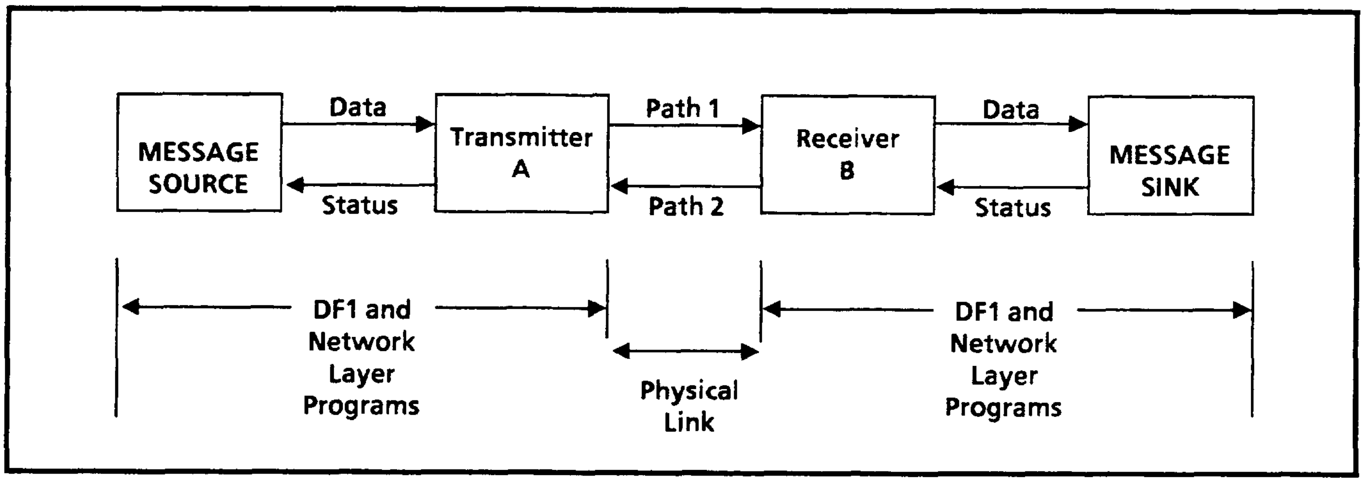
Protocol Environment

The DF1 link layer protocol requires an "environment," that is, a source for outgoing messages, and a place to put incoming messages. Thus, you must supply the DF1 layer a place to look for the messages it sends ("message source"), and a place to put the messages it receives ("message sink").

In other words, this description of DF1 protocol assumes you have created a MESSAGE SOURCE for the transmitter, and a MESSAGE SINK for the receiver (you can do this as part of the network layer. See "PCCC (Network) Layer" page 8-28).

Figure 8.9 illustrates the MESSAGE SOURCE and MESSAGE SINK functions.

Figure 8.9
Protocol Environment



DF1 Transmitter

The following is a more detailed description of a transmitter routine suggested for your host programming (see also Figure 8.10 and Table 8.C):

Whenever the transmitter is not busy, the transmitter looks to the message source (see "Network Layer"). If data is available, the transmitter sends the DLE STX, the data, and the DLE ETX BCC (the BCC is calculated as the data is gathered and sent).

The transmitter then starts a timeout and waits for a response from the receiver.

Note: Antenna transmitter timeout is 3 seconds. Your host timeout may vary from this.

DF1 Transmitter
(continued)

Timeout – If the timeout expires before the transmitter gets a response, it sends a DLE ENQ to request a retransmission of the last response sent. The transmitter restarts the timeout and waits for a response. The transmitter also sets a limit for and counts the timeouts received for a single message. Once the limit is reached, the transmitter should notify the message source that the transmission has failed.

Note: Antenna maximum number of ENQs sent is set to 10. Your host limit may vary from this.

DLE NAK – If transmitter gets a DLE NAK, it retransmits the same message. The transmitter restarts the timeout and waits again for a response. The transmitter also sets a limit for and counts the DLE NAKs received for a single message. Once the number of NAK's reaches this limit, the transmitter should notify the message source that the transmission has failed.

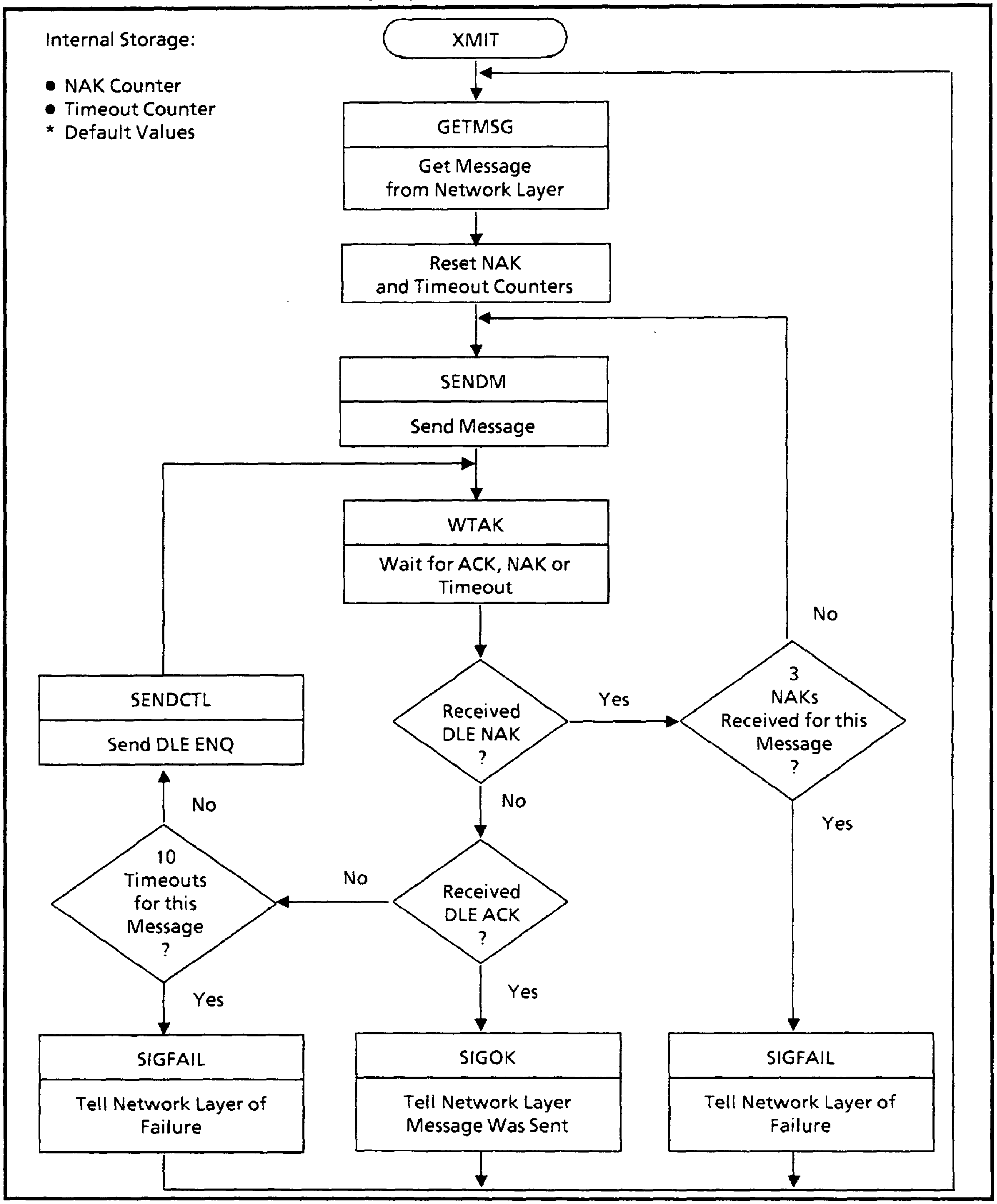
Note: Antenna NAK limit is set at 3. Your host limit may vary from this.

DLE ACK – If the transmitter gets a DLE ACK, the message transfer is complete. The transmitter signals the message source that the message has been sent successfully.

Note: DLE ACK and DLE NAK are the only defined response codes. If the receiver gets an invalid response code, it ignores it (see "DF1 Receiver").

DF1 Transmitter
(continued)

Figure 8.10
Detailed DF1 Transmitter Routine



DF1 Transmitter
(continued)

Table 8.C
Typical DF1 Transmitter Routine in Structured English

```
TRANSMITTER is defined as
     loop
     Message = GET-MESSAGE-TO-SEND
     Status = TRANSFER(Message)
     SIGNAL-RESULTS(Status)
     end

TRANSFER(Message) is defined as
     initialize nak-limit and enq-limit
     SEND(Message)
     start timeout
     loop

     WAIT for response on path 2 or timeout.

     if received DLE ACK then return SUCCESS
     else if received DLA NAK then
          begin
               if nak-limit is exceeded then return FAILURE
                    else
                         begin
                         count NAK retires;
                         SEND-MESSAGE(message);
                         start timeout
                         end

          end
     else if timeout
          begin
               if enq-limit is exceeded then return FAILURE
               else
                    begin
                    count ENQ retires;
                    send DLE ENQ on path 1;
                    start timeout
                    end

          end
     end loop

SEND(Message is defined as
     begin
     BCC = 0
     send DLE STX on path 1
     for every byte in the message do
          begin
          add the byte to the BCC;
          send the corresponding data code on path 1
          end
     send DLE ETX BCC on path 1
     end

GET-MESSAGE-TO-SEND
     This is an operating-system-dependent interface routine that waits and allows
     the rest of the system to run until the message source has supplied a message to
     be sent.

SIGNAL-RESULTS
     This is an implementation-dependent routine that tells the message source of
     the results of the attempted message transfer.

WAIT
     This is an operating-system-dependent routine that waits for any of several
     events to occur while allowing other parts of the system to run.
```

DF1 Receiver

Since the receiver gets noisy input from the physical world, the receiver routine is more complex than the transmitter routine. The receiver must respond to many situations, some of which are listed below:

- The message sink can be full, leaving the receiver with nowhere to put a message.
- A message can contain a parity error.
- The BCC can be invalid.
- The DLE STX or DLE ETX BCC may be missing.
- The message can be too long or too short.
- A spurious control or text code can occur outside a message.
- A spurious control code can occur inside a message.
- The transmitter may send a duplicate copy of a message that has already passed to the message sink due to response miscommunication.
- Any combination of the above can occur.

The receiver routine must handle all the above situations in specifically defined ways, as described below:

Message filtering – The receiver ignores all input until it receives a DLE STX or a DLE ENQ.

DLE ENQ – The receiver keeps a record of the last response code (DLE ACK or DLE NAK) sent. If the receiver receives a DLE ENQ, the receiver resends the response.

DLE STX data – When the receiver gets a DLE STX, it resets its data buffer to zero and stores the data in the data buffer for transfer to the network layer.

Calculate Block Check Character (BCC) – If the receiver gets a DLE STX, it resets a BCC accumulator. While the receiver stores data codes in the data buffer, it adds the data code values to the BCC accumulator (see Appendix B for BCC calculation).

Note: On the antenna, if the data buffer overflows, the receiver continues summing the BCC, but discards the data.

DF1 Receiver *(continued)*

> **Note:** On the antenna, if the receiver sees any control code other than DLE ETX after the DLE STX is received, it aborts the message and sends a DLE NAK. An exception is an embedded response (DLE NAK or DLE ACK) which occurs in the data field. See page 8-23 for embedded response information.

DLE ETX BCC – When the receiver gets a DLE ETX BCC, it checks the error flag, the BCC, the data message size, and the destination station number. If any of the tests fail, the receiver sends a DLE NAK on path 2 (see Figure 8.7).

> **Note: Error Testing** – On the antenna, the receiver sets an error flag to indicate the occurrence of a buffer overrun, parity error, message framing error, or modem handshaking error. Your host receiver should do the same (see Table 8.D for more detail regarding these checks).

If the received message passes the above tests, the receiver next checks for duplicate message.

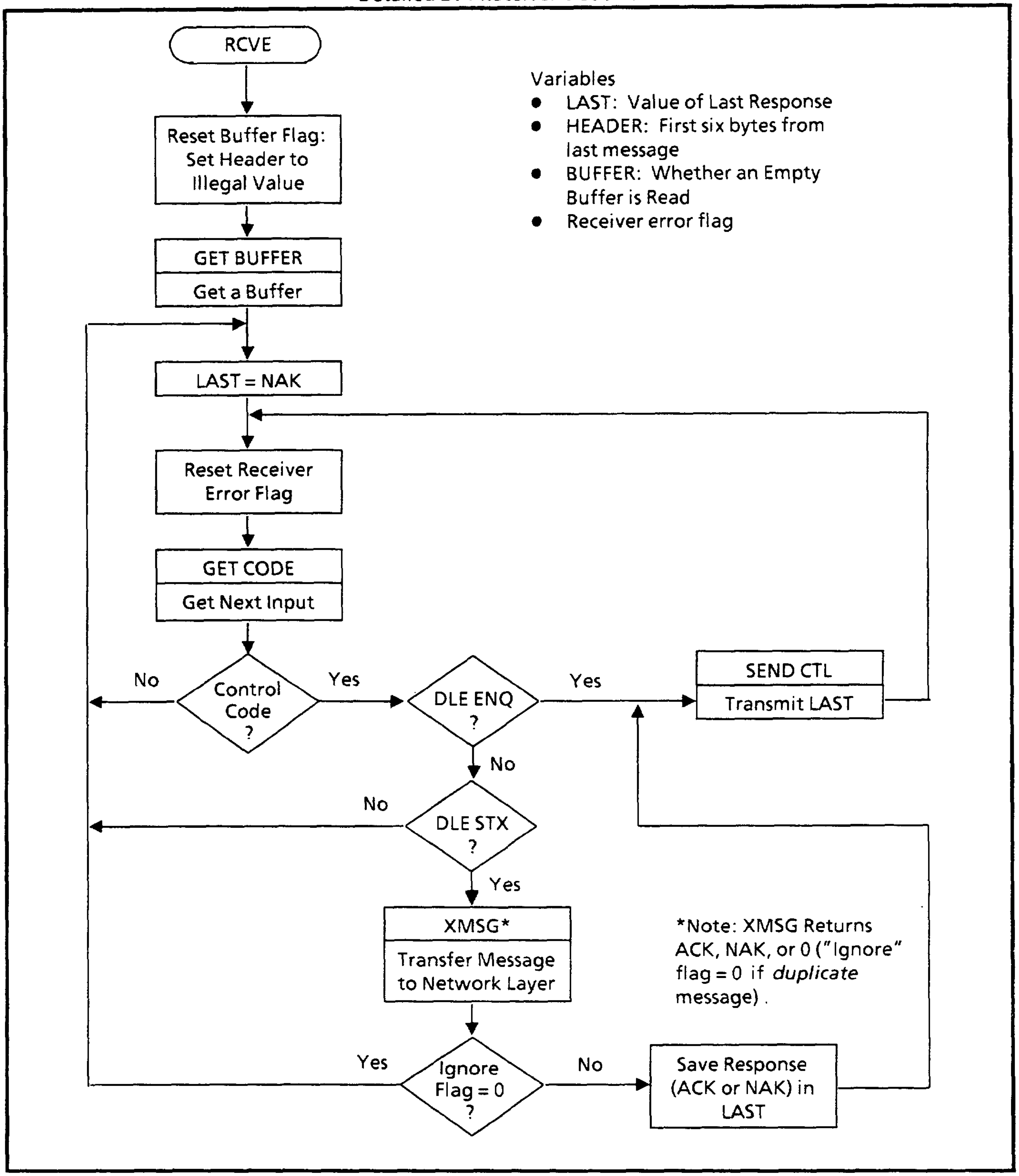
Duplicate Message Protection – The receiver keeps a record of the first six data bytes after the DLE STX, until the next DF1 message is received, for duplicate message protection. The same bytes of a new message are compared identical to this record; if identical, the receiver responds with a DLE ACK but ignores the new message. This routine guards against re-execution of a command that has already been received successfully, but sent again due to some kind of response miscommunication.

If the received message is not a duplicate, the receiver next checks to see if the message sink is full. If full, the receiver sends a DLE NAK response. Otherwise, the receiver:

- Forwards the received data to the message sink.
- Sends a DLE ACK response to be sent back to the transmitter of the antenna.
- Keeps a copy of the first six bytes of the data for duplicate message detection.

DF1 Receiver
(continued)

Figure 8.11
Detailed DF1 Receiver Routine



DF1 Receiver
(continued)

Table 8.D
Typical DF1 Receiver Routine in Structured English

```
RECEIVER is defined as
    variables
        LAST-HEADER is 4 bytes copied out of the last good message
        RESPONSE is the value of the last ACK or NAK sent
        BCC is an 8-bit block check accumulator

    LAST-HEADER = invalid
    LAST RESPONSE = NAK

    loop
        reset error flag
        GET-CODE
        if DLE STX then
            begin
                BCC = 0
                GET-CODE
                while it is a data code
                    begin
                    if buffer is not overflowed put data in buffer
                    GET-CODE
                    end
                if the control code is not a DLE ETX then send DLE NAK
                else if error flag is set then send DLE NAK
                else if BCC is not zero then send DLE NAK
                else if message is too small then send DLE NAK
                else if message is too large then send DLE NAK
                else if message sink is full send DLE NAK
                else if header is same as last message send a DLE NAK
                else
                    begin
                        send message to message sink
                        send a DLE ACK
                        save last header
                    end
            end
        else if DLE ENQ then send LAST-RESPONSE
        else LAST-RESPONSE = NAK
    end
```

DF1 Receiver (continued)

Table 8.D (continued)
Typical DF1 Receiver Routine in Structured English

```
GET-CODE is defined as
    loop
        variable
        GET-CHAR
        if char is not a DLE
            begin
                add char to BCC
                return the char and data flag
            end
        else
            begin
                GET-CHAR
                if char is a DLE then effect DLE stuffing
                    begin
                        add char to BCC
                        return a DLE and a data flag
                    end
                else if char is an ACK or NAK send it to the transmitter
                else if char is an ETX
                    begin
                        GET-CHAR
                        add char to BCC
                        return ETX with a control flag
                    end
                else return character with a control flag
            end
        end
    end
GET-CHAR is defined as
    an implementation dependent function that returns one
    byte of data from the link interface hardware.
```

Embedded Responses

Response codes (**DLE ACK** or **DLE NAK**) from a host's receiver can be placed in the data field (between the **DLE STX** and **DLE ETX BCC**) of the transmitter DF1 message. These receiver responses within the DF1 data field are referred to as "embedded responses." The response codes in the data field are distinguished from data by the **DLE** prefix.

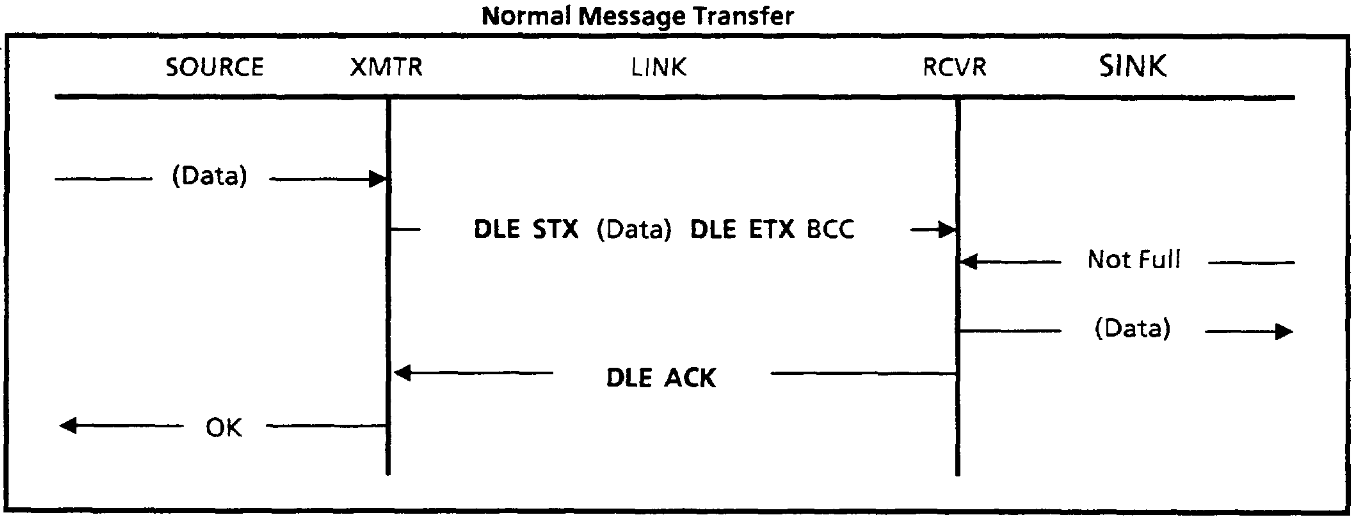
You can use embedded responses in order to speed up the communication process. For example, the **DLE ACK** or **DLE NAK** for a previously received message might be placed in the DF1 data field of the currently outgoing data transmission, rather than waiting for the entire message to be transmitted, then sending the **DLE ACK** or **DLE NAK.**

The 2750-AS series antennas can accept, but do not generate, embedded responses.

Full-Duplex Protocol Examples

The following figures show some events that can occur on the various interfaces. Control characters are shown in bold type. BCC is shown at the end of each message packet. Time is represented as increasing from the top of the figure to the bottom. Figure 8.12 shows normal message transfer.

Figure 8.12
Normal Message Transfer



Full-Duplex Protocol Examples *(continued)*

Figure 8.13 shows a DLE NAK response to the initial message transmission. After the message is retransmitted, a DLE ACK response is given.

Figure 8.13
Message Transfer with NAK

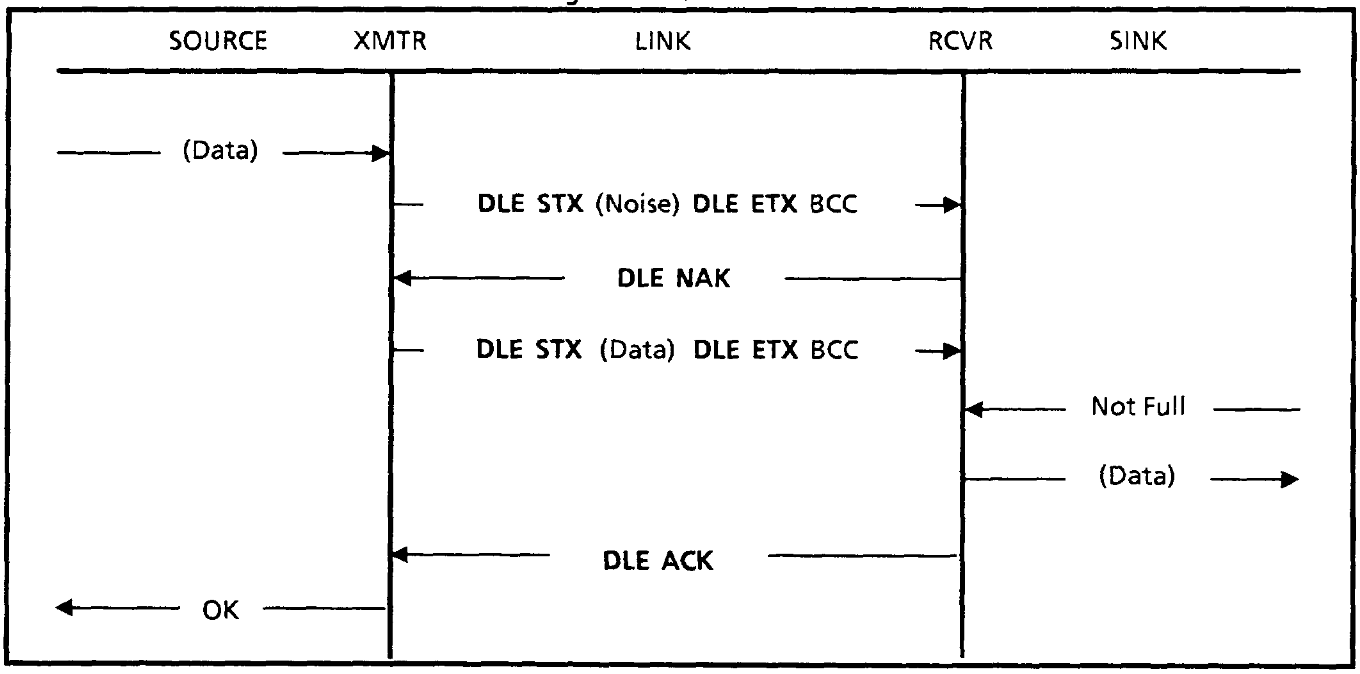
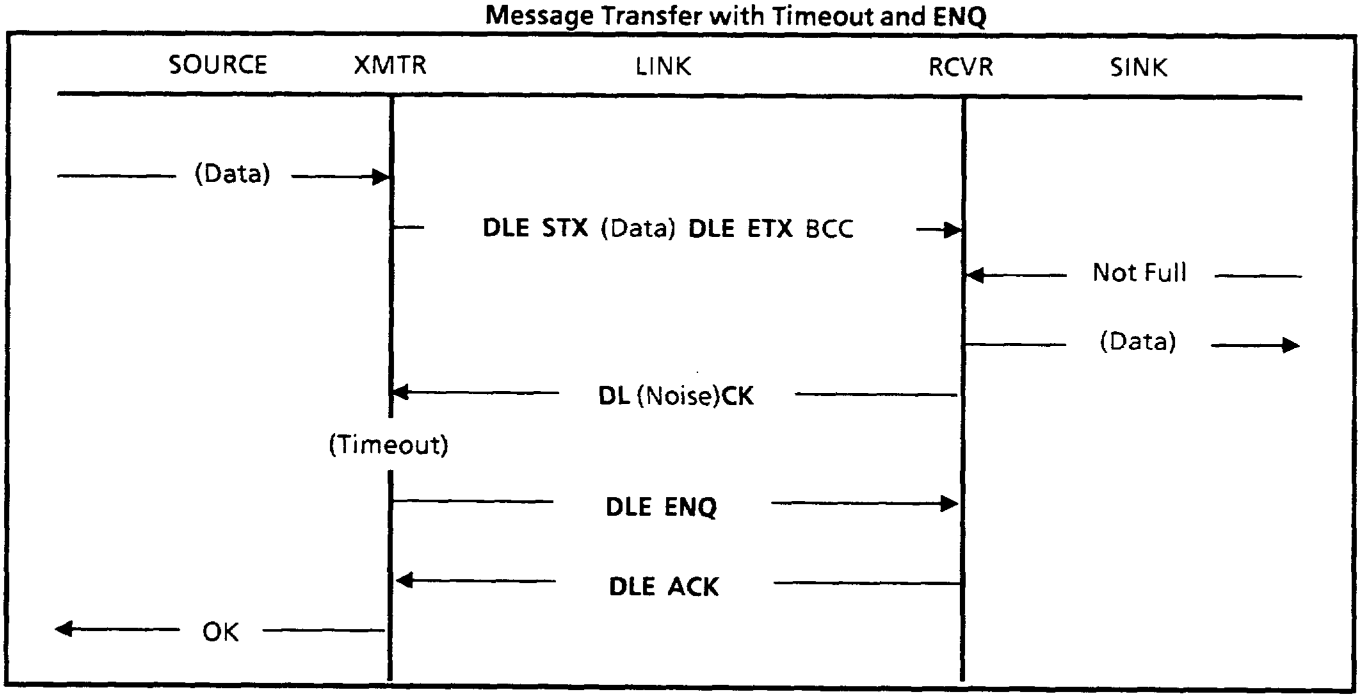


Figure 8.14 shows the transmitting station sending a DLE ENQ sequence after a timeout because it did not receive the initial DLE ACK response.

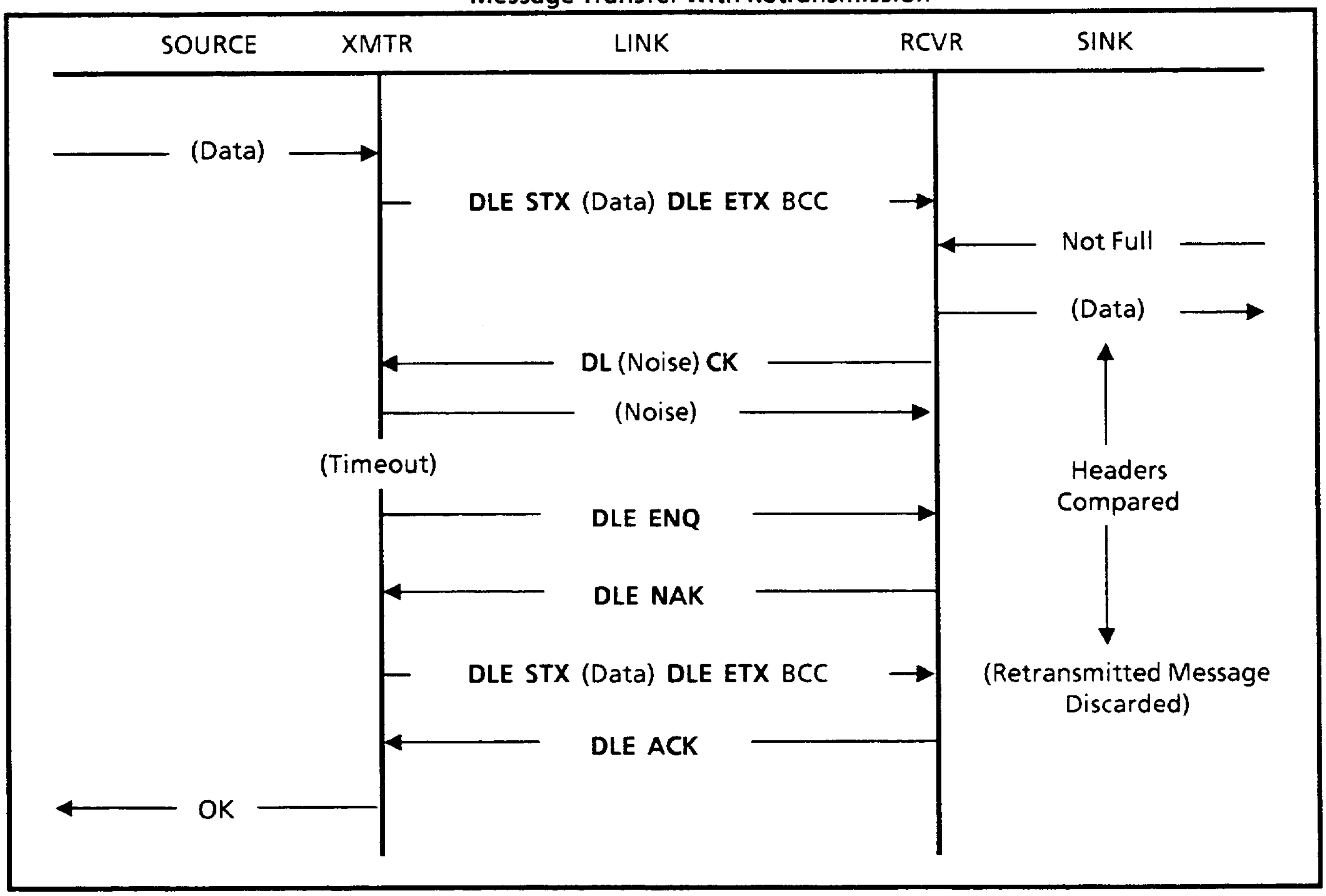
Figure 8.14
Message Transfer with Timeout and ENQ



Full-Duplex Protocol Examples *(continued)*

In Figure 8.15, noise hits both sides of the line. This destroys the DLE ACK while also producing invalid characters at the receiver. The result is receiver sends a NAK and the transmitter retransmits the original message.

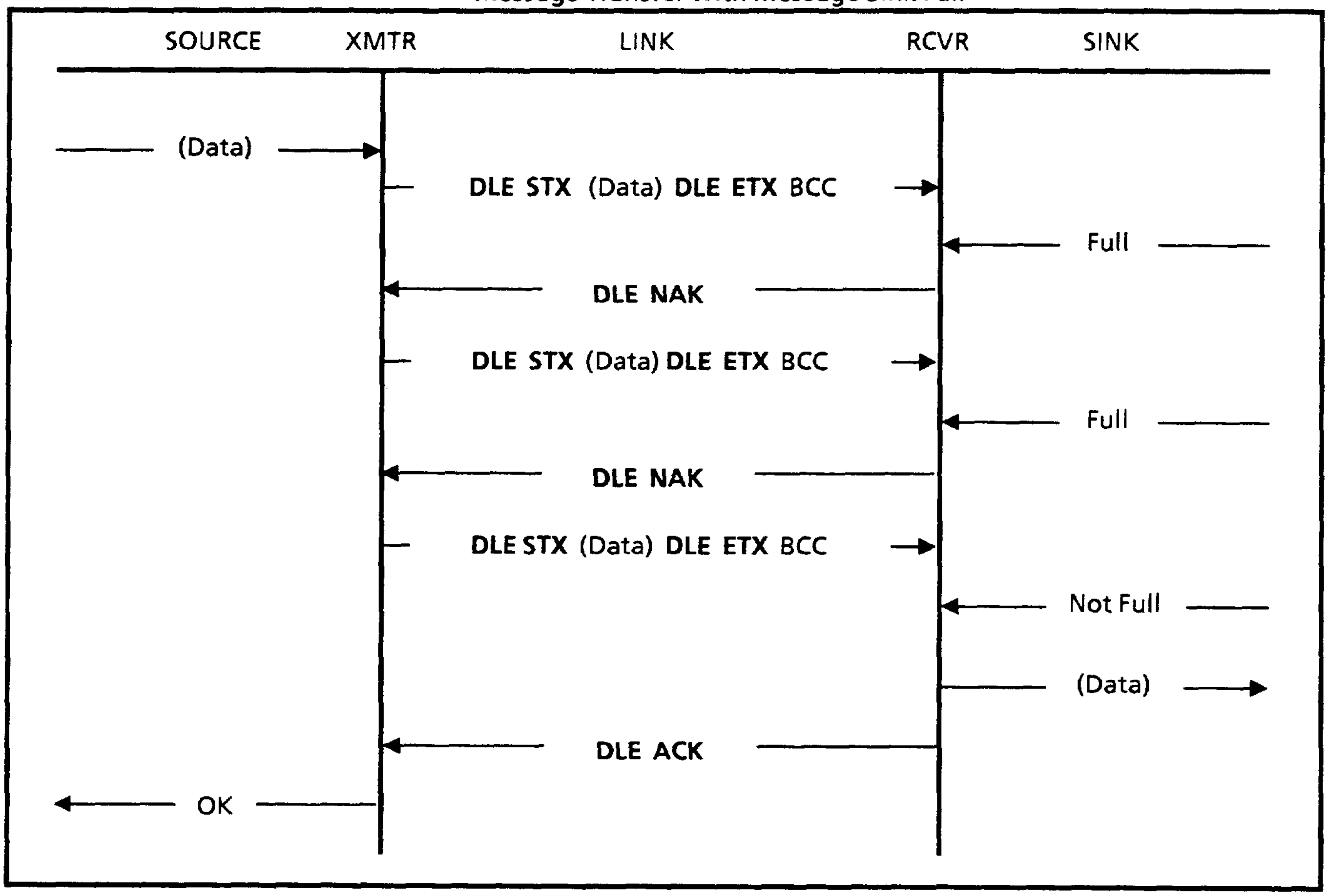
Figure 8.15
Message Transfer with Retransmission



Full-Duplex Protocol Examples (continued)

Figure 8.16 shows a DLE NAK response to the initial message transmission because the message sink is full. After the message sink is no longer full, a retransmission of the message causes a DLE ACK response.

Figure 8.16
Message Transfer with Message Sink Full



Full-Duplex Protocol Examples (continued)

If you were to connect a line monitor to the wires between station A and B, you could observe the following (see Figure 8.17). Note that Paths 1 and 4 are carried on the same physical transmit line, as are Paths 2 and 3:

Figure 8.17
Monitoring Full-Duplex Messages

Normal message

Path 1:	DLE STX (Data) DLE ETX BCC→		DLE STX (Data) DLE ETX BCC→	
Path 2:		←DLE ACK		←DLE ACK

Message with parity or BCC error and recovery

Path 1:	DLE STX (Noise) DLE ETX BCC→		DLE STX (Data) DLE ETX BCC→	
Path 2:		←DLE NAK		←DLE ACK

Message with ETX destroyed

Path 1:	DLE STX (Data) (Noise) [timeout] DLE ENQ→		DLE STX (Data) DLE ETX BCC→	
Path 2:		←DLE NAK		←DLE ACK

Good message but ACK destroyed

Path 1:	DLE STX (Data) DLE ETX BCC→		[timeout] DLE ENQ→	
Path 2:		←DL (Noise) CK		←DLE ACK

Messages going in both directions; embedded response on Path 2 (DLE ACK among Path 3 data)

Path 1:	DLE STX (Data) DLE ETX BCC→		DLE STX (Data) DLE ETX BCC→		DLE STX→
Path 2:		←DLE ACK		←DLE ACK	
Path 3:	←DLE STX (Data)		←(Data) DLE ETX BCC		←DLE STX
Path 4:				DLE ACK→	

Combined–

Circuit AB:	DLE STX (Data) DLE ETX BCC→	DLE STX (Data) DLE ETX BCC DLE ACK DLE STX→	
Circuit BA:	←DLE STX (Data) DLE ETX BCC		←DLE ACK DLE STX

ACK on AB delayed slightly because ETX BCC are indivisible

PCCC (Network) Layer

The network layer provides a means of interaction between application programs, such as those of the host computer and the antenna. The network command format transfers antenna commands from the host to the antenna. The DF1 driver delivers these network messages within the DF1 data field to the antenna.

The network layer consists of the following basic attributes, which are discussed in this section:

- Two application programs which exchange messages (i.e., host command initiator to antenna command executor, or antenna command initiator to host command executor).
- Defined message format for command and response, consisting of defined fields in a particular sequence, and data (in command only). Each network command requires a corresponding network response.*
- Message number and timer for tracking the response to a particular command (for administration of timer and message number, see "DF1 Application Layer," page 8-34).
- Error code administration.

*Note: The antenna network level responses can be disabled (see "DF1 responses disabled" under "Options" in Table 9.G, page 9-13).

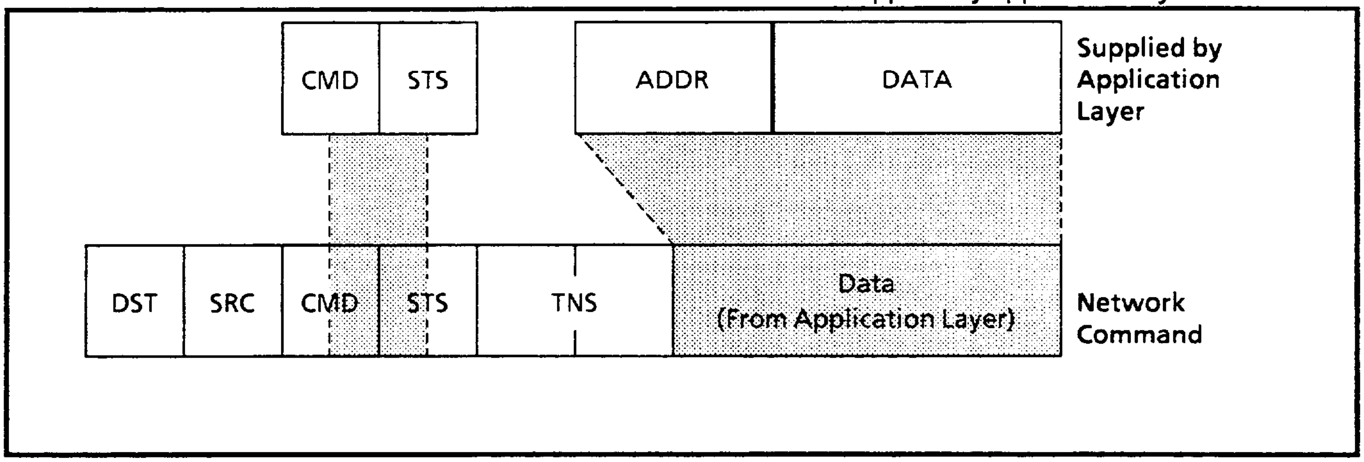
DF1 (Link Layer) Interface Requirements

Because the network protocol relies on the DF1 data link driver to deliver the network messages, the network layer must provide a MESSAGE SOURCE to the DF1 driver, a place to get messages for transmission. The DF1 transmitter should accept a network message as data for delivery, try to send it, and indicate whether it was delivered.

The network layer should also provide a MESSAGE SINK to the DF1 driver. The DF1 receiver delivers the received data to the message sink, for transfer to a network message queue (see "Network/Application Interface Model," page 8-43).

DF1 (Link Layer) Interface Requirements
(continued)

Figure 8.18
Network command with data supplied by application layer



Program and Message Types

Application programs, such as that of the host and antenna, communicate by sending information in the network command format. Information from the application layer is placed in the network format (see Figure 8.18).

The network protocol is designed to enable interaction between two types of application programs (refer to Figure 8.19 for the following):

Command initiator - initiates commands carried over the network to a command executor (command initiator can be either **host**, sending a command to the antenna, or **antenna**, sending a response to host. See 1.a and 3.a, Figure 8.19).

Command executor - accepts commands over the network and replies (steps 2.a and 4.a).*

Correspondingly, there are two network message types:

Network commands - sent by command initiator to a command executor (steps 1.a and 3.a).

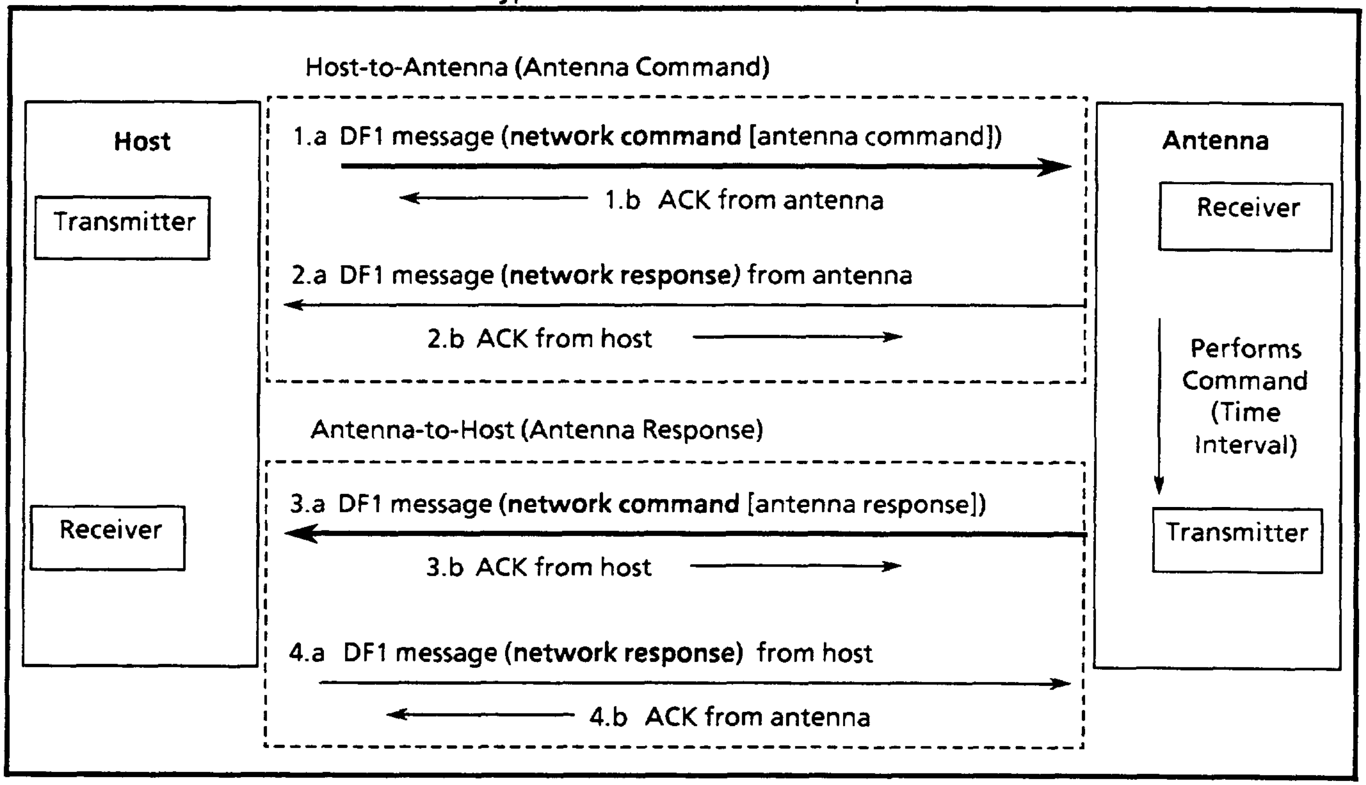
Network responses - sent by command executor to command initiator in response to command (steps 2.a and 4.a).*

* **Note:** The network level responses (in Steps 2.a and 4.a) can be disabled (see "DF1 responses disabled" under the "Options" byte in Table 9.G, page 9-13).

Program and Message Types (continued)

Your host application program acts as both command initiator (sending commands to the antenna in a network command format), and a command executor (receiving antenna responses in a network command format).

Figure 8.19
Typical DF1 Host / Antenna Unprotected Write Commands



Network Command and Response Formats

The network protocol employs two message formats – the network command format (Figure 8.20), and the network response format (Figure 8.21).

The labeled boxes in the diagrams represent two-digit hex fields (the TNS is a four-digit field). Fields are shown from left to right in the order in which they are transmitted on the link (see DF1 Protocol this chapter for complete message transmitted).

The network command includes values and data supplied by the application layer (see "Application Layer" this chapter).

Note that the response is similar to the command format, but includes no data. Refer to "Network Message Field Descriptions" for description and defined values for each field.

Network Command and Response Formats *(continued)*

Figure 8.20
Command Message Format

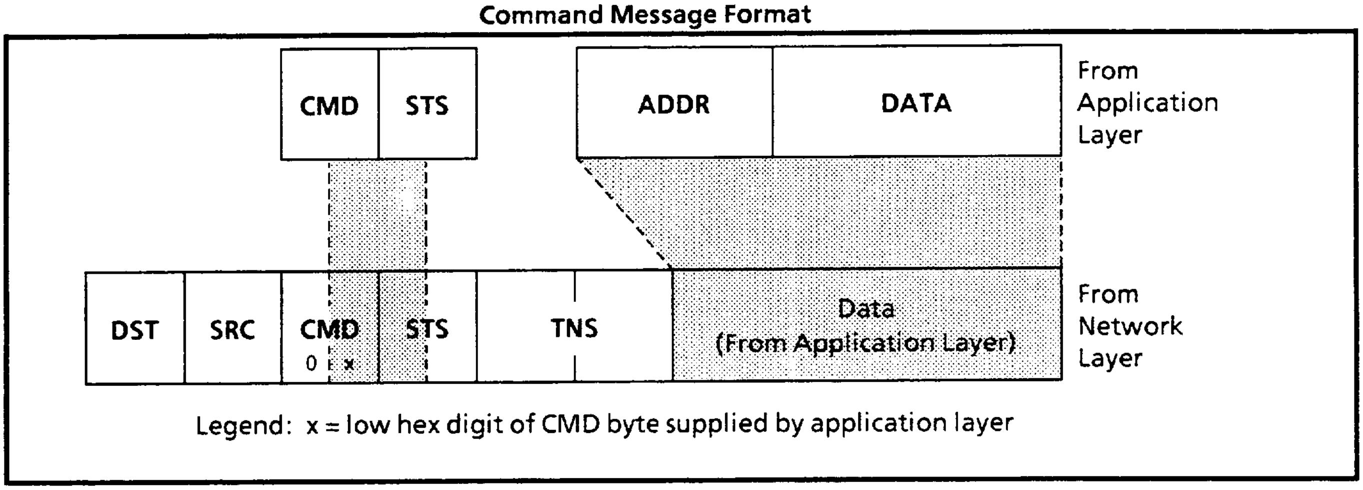
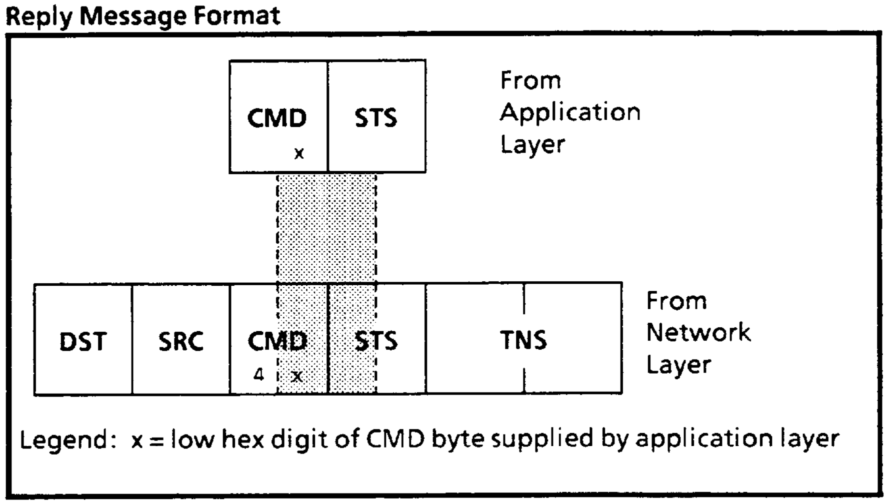


Figure 8.21
Reply Message Format



Network Message Field Descriptions

The network command and network response formats both have the same six defined fields as a "header." The response format contains no data field. The network fields are described below and in Tables 8.E and 8.F:

DST – The DST (destination) field is the number of the station to which the network command/response is delivered. Use DST value of "00" for communication with the antenna.

SRC – The SRC byte is the number of the station that sent the message. Use any of 238 possible station numbers, from 1 to 63 and 72 to 254 decimal (01- 3F and 48-FE Hex).

Network Message Field Descriptions *(continued)*

Note: The DST of a network command becomes the SRC of the corresponding response. The SRC of the command becomes the DST of the response.

CMD (High Hex Digit) – The CMD (command) field, high Hex digit, identifies the message as a network command, or network reply. A value of 0 is used in the high Hex digit of the CMD field in network commands; 4 is used in reply messages (**Note:** the low byte is the command code, supplied by application program).

STS – The STS (status) field carries error messages in network responses only. In a command message, this field is set to zero. In a reply message reporting no error, this field is set to zero.

High Hex Digit – The high Hex digit of the STS (status) byte is supplied by the network layer for "local errors." A local error occurs if the network layer of your host cannot deliver a command to antenna due to some network protocol violation. It can write a "local error" code into this field, and return the message to the command initiator in your application layer. Error codes are listed in Table 8.G, page 8-33.

Low Hex Digit – The low nibble of the STS byte is used for reporting remote errors. Remote errors mean that a command was successfully delivered, but the antenna is unable to execute it. The antenna reply contains a copy of the low nibble of the "Results" code returned in "Perform" command response format (see Table 8.J, page 8-24).

TNS – The TNS (transaction) is a four-digit Hex field. A unique four-digit Hex value is assigned to each network command issued by the application program. The TNS is copied from the network command into the TNS field for the corresponding response. This enables the command initiator to associate an incoming reply message with one of the command messages it transmitted previously.

Network Message Field Descriptions
(continued)

Table 8.E
Network Command Header Values

Fields	DST	SRC	CMD	STS	TNS
Hex Value	00	01-3F, 48-FE	0 x	00	x x x x
Meaning	Destination – the station to which the network command/ response is delivered. Set to 00 for host commands to antenna.	Station Return Code – the number identifying the station issuing the network message. Use any value above.	Command – high Hex digit identifies the message as a network command, or network reply. A "0" is used to indicate commands.	Status – set to 00 in commands.	Transaction – Four-digit Hex value, unique for each command sent. Assigned by command initiator.

Table 8.F
Network Response Header Values

Fields	DST	SRC	CMD	STS	TNS
Hex Value	x x	01-3F, 48-FE	4 x	x x	x x x x
Meaning	Destination – the station to which the network command/ response is delivered. Set to SRC value of corresponding command.	Station Return Code – the number identifying the station issuing the message.	Command – high Hex digit identifies the message as a network command, or network reply. A "4" is used for reply messages.	Status – (set by antenna according to any error flags set. See Table 7.G for Error Codes).	Transaction – Copied from corresponding command TNS, and used to match response with command.

Table 8.G
Network "Local Error" Codes

STS Hex Value	Return Code	Description
10	BADCMD	Antenna does not recognize command as valid.
30	BADFNC	Antenna does not implement this command.
50	BADADDR	Non-sequential unprotected write or an invalid address.
70	BADMODE	Improper message mode transmission (large-small, enter, exit) attempted.

DF1 Application Layer

Your host application program operates the RFID system through timely transmission of commands to the antenna, and evaluation of antenna responses. This section tells how to apply the network protocol command/response format to communicate with and operate the antenna.

The mainstay of the host/antenna communication is a network command called the "Write Unprotected Command," which is discussed at length in this section.

Command Initiators and Executors

Command Initiator – One of the functions of your host application program is to initiate commands to the antenna. Thus part of your programming requires a "command initiator."

Referring to Figure 8.22 , Step 1.a (containing the antenna command) would be the result of a command initiator action. The antenna response information in Step 3.a would be accepted by the command initiator.

The host program may have one or more command initiators. The host command initiator is responsible for:

- Creating a message packet (with IDP command) and submitting that packet to the network layer.
- Generating the TNS number for the network command messages.①
- Maintaining a timer for each outstanding network command issued.②
- Administering the command sequence number within the IDP command format
- Destroying the antenna response when no longer needed
- Canceling the timeout and sequence number

① One way to generate the TNS is to maintain a 16-bit counter. Increment the counter every time your command initiator creates a new message, and store the counter value in the two TNS bytes of the new message.

② The network protocol does not guarantee message delivery, and in some cases may not provide notification of non-delivery. Thus the command initiator should maintain a timer for each outstanding command.

Command Initiators and Executors *(continued)*

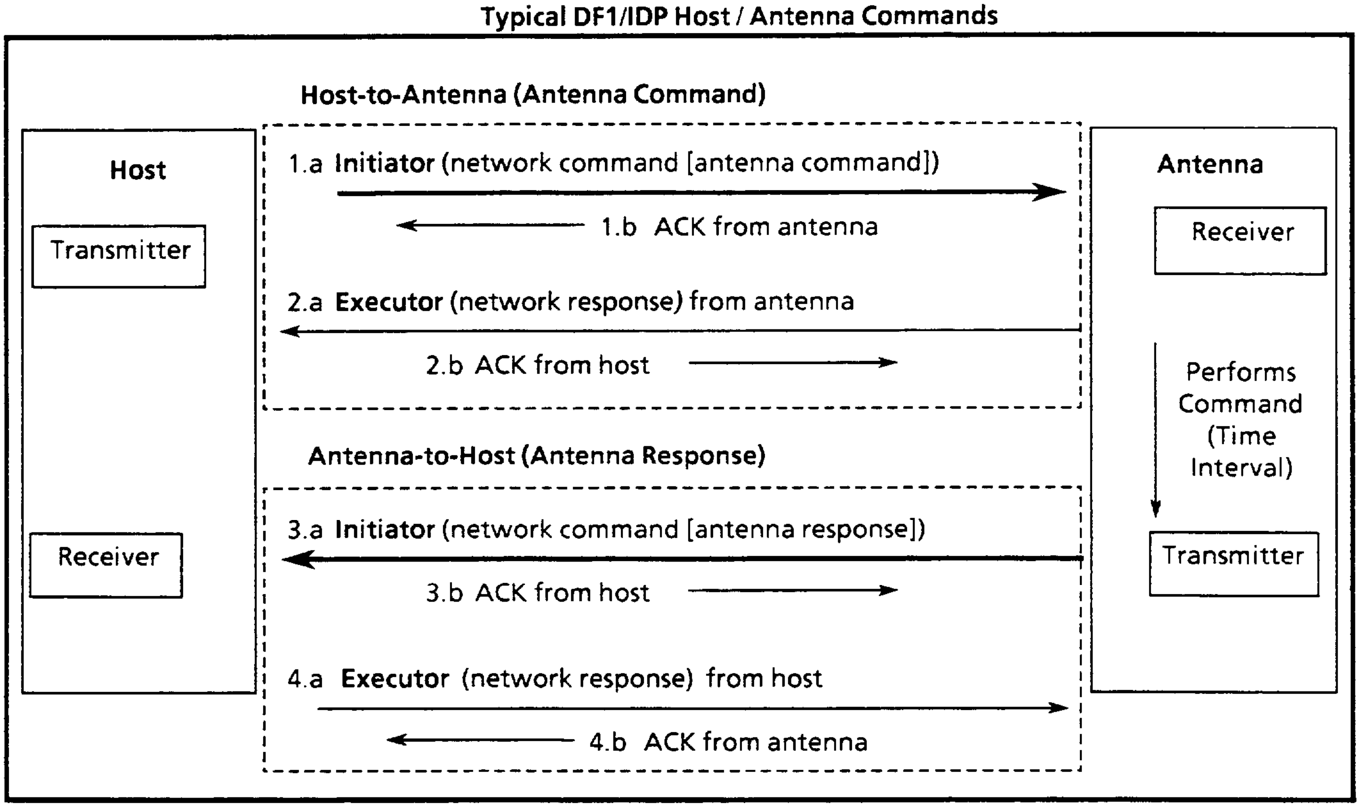
Command executor – Another function of your host program would be to accept responses from the antenna (in the form of a network command from the antenna), and also accept network responses from the antenna network layer. These actions would be part of a "command executor."

Referring to Figure 8.22 , Steps 2.a, 3.a, and 4.a would entail involvement of the host command executor.

The host application program should have at least one command executor to do the following:

- Accept the antenna reply (Step 3.a, Figure 8.22) and submit the antenna response information to the command initiator
- Copy over certain information from the network command to the network format to generate a network response (step 4.a)
- Fill in any reply information (STS byte in the network command)
- Submit the information to the network
- Destroy the command packet when no longer needed.

Figure 8.22
Typical DF1/IDP Host / Antenna Commands



Unprotected Write Command

The host communicates with the antenna by sending information within the network command format. To do this, your host program would need to use a network (PCCC) command called the "Unprotected Write Command."

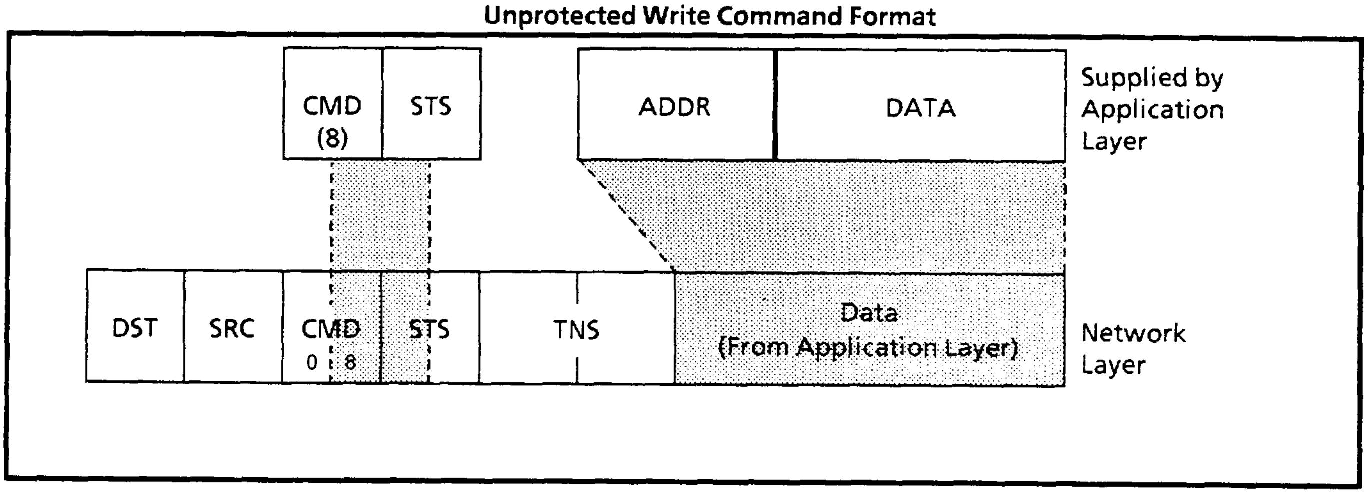
Refer to Figure 8.23 for the Unprotected Write command format. This command can be used to perform different functions, depending on the value entered in the ADDR field (see "Functions of the Unprotected Write Command" on the next page).

To send an IDP command to the antenna, you insert the IDP command into the data field of an Unprotected Write command (see Figure 8.22, step 1.a).

The antenna responds to the host using the Unprotected Write command format (see Figure 8.22, step 3.a). The antenna also generates a "Unprotected Write Response" (Fig 8.22 , Step 2.a), if the DF1 response function is enabled (see Chapter 9, "Set Interface Configuration").

The host also must send the "Unprotected Write Response," if the DF1 response function is enabled, as part of the communication sequence. Your host command executor uses this response to reply to the network command from the antenna (see Figure 8.22, step 4.a).

Figure 8.23
Unprotected Write Command Format



Functions of the Unprotected Write Command

The Unprotected Write command can be used in several ways, depending on the value you insert in ADDR (address) field (see Figure 8.23). The ADDR values and corresponding functions are listed in Table 8.H. The different functions are discussed in following sections.

Table 8.H
Functions of the Unprotected Write Command

ADDR Field Value (Hex)	Command Function
0100	Enable Unsolicited Responses
0102	Enter Large Message Transfer Mode (data greater than 242 bytes)
0104	Exit Large Message Transfer Mode
0200	Small Message Transfer Mode (data ≤ 242 bytes)
≥ 0200	Large Message Segment

Note: The antenna uses the Unprotected Write Command "Small Message Transfer Mode" to send response information to the host (see "Small Message Transfer Mode," page 8-39).

Functions of the Unprotected Write Command (continued)

Enable/Disable Unsolicited Response

The Enable/Disable Unsolicited Response allows you to limit the number of antenna responses to a command to none (0), unlimited, or any specified number up to 65,534. To use this type of Unprotected Write command, specify 0100 Hex in the ADDR field. Insert the 4 bytes in the data field as shown in the example format below to set the limit on unsolicited responses.

Command Format (Enable Unsolicited Responses):

DST	SRC	CMD 08	STS	TNS	ADDR 0100 hex	DATA* (4 bytes)

*Data

Word 0 (bytes 0 + 1)	Network address to be used in unsolicited responses. This address value must be (1) even; (2) ≥ 0100 with Byte Swapping Mode Enabled; (3) ≥ 0200 with Byte Swapping Mode Disabled. Default: Byte Swapping Enabled = 0100 (Hex) Byte Swapping Disabled = 0200 (Hex) Note: With Byte Swapping Enabled, this value will be multiplied by 2 to compensate for byte address to word address conversion.
Word 1 (bytes 2 + 3)	0000 (hex) = Antenna disabled from sending unsolicited responses. 0001–FFFE (hex) = Antenna can send up to this number of unsolicited responses. FFFF (hex) = Default; no limit on unsolicited responses.

Reply Format:

DST	SRC	CMD 48	STS	TNS

Functions of the Unprotected Write Command (continued)

Small Message Transfer Mode

This is the usual method of sending antenna commands to the antenna and also for the antenna to send unsolicited responses to the host.

To use this type of Unprotected Write command, insert the value 0200 Hex as the ADDR value. Enter the IDP command in the data field following the ADDR value (see Chapter 9 for IDP commands).

Command Format (Small Message Transfer):

DST	SRC	CMD 08	STS	TNS	ADDR 0200 Hex	DATA – Max of 242 bytes

Reply Format:

DST	SRC	CMD 48	STS	TNS

Functions of the Unprotected Write Command (continued)

Enter Large Message Transfer Mode

Use this command when you intend to send command information to the antenna requiring a data field larger than the 242 bytes allowed in a single network data field. To use this type of Unprotected Write command, specify 0102 Hex in the ADDR field. Enter any two bytes* in the data field, as shown in the format below. After you use this command, the antenna expects successive "Large Message Segments" containing your message to the antenna (see "Large Message Segments," next page). To end a series of segments, see "Exit Large Message Transfer Mode."

> ***Note:** The two bytes in the data field of this command are place-holding bytes only; this data field should not be used to convey part of an IDP message intended for the antenna.

Command Format (Enter Large Message Transfer Mode):

DST	SRC	CMD 08	STS	TNS	ADDR 102 hex	DATA –Must be 2 bytes

Reply Format:

DST	SRC	CMD 48	STS	TNS

Functions of the Unprotected Write Command (continued)

Large Message Segment

Use this command immediately after the "Enter Large Message Segment" command. For the first message segment, use ADDR value of 0200 Hex (the same as the "Small Message Transfer"). Subsequent message segments each have an ADDR value incremented by the number of data bytes in the previous segment.

Also, the transaction number (TNS) must be one more than the previous segment (or Enter Large Message Transfer Mode command).

The SRC value must be the same in all segments (including Enter Large Message Transfer Mode command).

The data field of the first large message segment must contain an Antenna command header (see Chapter 9 for IDP command formats).

Command Format (Large Message Segment):

DST	SRC	CMD 08	STS	TNS	ADDR ≥ 0200 hex*	DATA – Max of 242 bytes

* The initial Address must be 0200 Hex. For each subsequent message segment, increment the address by the number of data bytes in the previous segment.

Reply Format:

DST	SRC	CMD 48	STS	TNS

Functions of the Unprotected Write Command (continued)

Exit Large Message Transfer Mode

Use this command to terminate a large message sequence, informing the antenna interface that no more segments are coming.* After the antenna receives this command, no more message segments are expected. The command is accepted and a network reply is sent, but the message is not passed onto the application layer.

The TNS value must be one more than the last "Large Message Segment" command in the sequence.

> ***Note:** Sending this command immediately after sending the "Enter Large Message Segment" command, without sending at least one "Large Message Segment," will cause the antenna to generate a response with an error message.

Command Format:

DST	SRC	CMD 08	STS	TNS	ADDR 0104 Hex

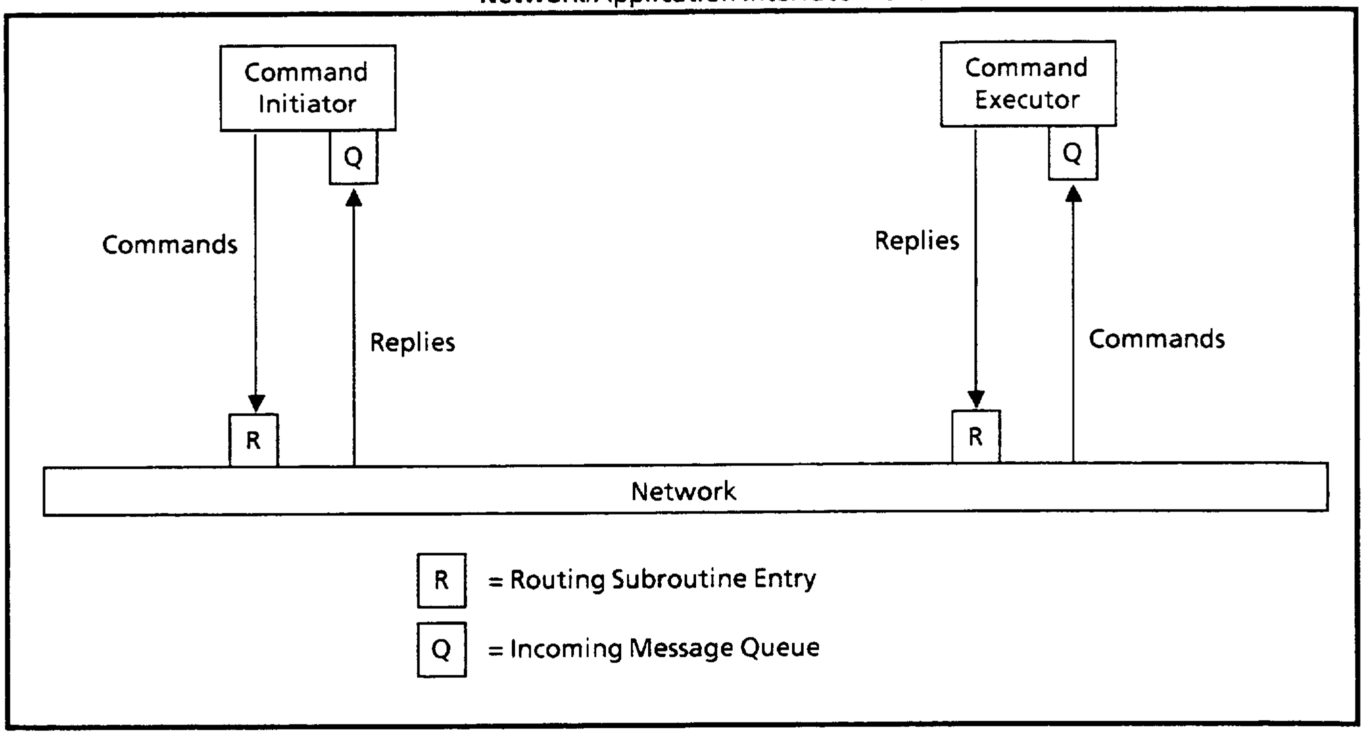
Reply Format:

DST	SRC	CMD 48	STS	TNS

Network/Application Interface Model

To implement your network layer, use a routing subroutine and a queue to interface with your application layer. Messages that have been created by the application layer are sent to the network router for transfer to the DF1 link layer. Messages received from the link layer are placed by the network on an incoming message queue. Figure 8.24 illustrates this model.

Figure 8.24
Network/Application Interface Model



Response messages are not necessarily received in the same order that the corresponding command messages were sent. The application layer is notified via the operating system when a message arrives on the queue. Messages do not have to be removed from the queue in order of arrival.

The network protocol does not notify the command executor in case of non-delivered reply message.

Diagnostic Loop

Use this command to test the integrity of transmission over the communication link. It transmits up to 242 bytes of data to the Host Interface. The antenna responds by returning the same data it receives. If the returned data not the same as the command data, the test fails.

Command Format:

DST	SRC	CMD 06	STS	TNS	FNC 00	DATA – Max of 242 bytes

Reply Format:

DST	SRC	CMD 46	STS	TNS	DATA – Max of 243 bytes

Byte Ordering

The information in the data field of a DF1 (link layer) message (which includes the network protocol messages) is transmitted and received in one of two modes – either with "byte swapping" enabled, or "byte swapping" disabled. The difference in modes is in the byte ordering – i.e., whether the lower order byte of each word is transmitted before, or after, the higher order byte of that word. Refer to Chapter 5 to select either mode.

Example Byte Ordering

Given a network command message which includes an IDP (antenna) "Echo Command" and data (see Chapter 9 for command formats), the command fields for "byte swapping" disabled could be diagramed as in Table 8.J:

Table 8.J
Network and IDP Command Fields – "Echo" Command

	Example Command Format				
	Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
Start of Network Layer	00	DST (= 00)	(00)	SRC (= 01)	(01)
	01	CMD (= 08)	(02)	STS (= 00)	(03)
	02	TNS (MSB, = XX)	(04)	TNS (LSB, = XX)	(05)
	03	ADDR (MSB, = 02)	(06)	ADDR (LSB, = 00)	(07)
Start of IDP Layer	04	Command (= 01)	(08)	00	(09)
	05	00	(0A)	00	(0B)
	06	Seq. No. (MSB, = XX)	(0C)	Seq. No. (LSB, = XX)	(0D)
	07	Sensor No. (MSB, = 00)	(0E)	Sensor No. (LSB, = 00)	(0F)
	08	"A" (ASCII)	(10)	"B"	(11)
	09	"C"	(12)	"D"	(13)
	0A	"E"	(14)	00	(15)

The order of transmission of the bytes shown in Table 8.J on the link layer for both modes would be as shown in Table 8.K (including DF1 control characters).

Example Byte Ordering *(continued)*

Table 8.K
Example Transmission Mode Byte Orders

	Word Offset	Byte Offset	Byte Swapping Enabled*	Byte Swapping Disabled
DF1 Layer			DLE	DLE
			STX	STX
Start of Network Layer	00	00	SRC	DST
		01	DST	SRC
	01	02	STS	CMD
		03	CMD	STS
	02	04	TNS (LSB)	TNS (MSB)
		05	TNS (MSB)	TNS (LSB)
	03	06	ADDR (LSB)	ADDR (MSB)
		07	ADDR (MSB)	ADDR (LSB)
Start of IDP Layer	04	08	Return Code	Command
		09	Command	Return Code
	05	0A	Sensor Status	Interface Status
		0B	Interface Status	Sensor Status
	06	0C	Seq. No. (LSB)	Seq. No. (MSB)
		0D	Seq. No. (MSB)	Seq. No. (LSB)
	07	0E	Sensor No. (LSB)	Sensor No. (MSB)
		0F	Sensor No. (MSB)	Sensor No. (LSB)
	08	10	"B"	"A"
		11	"A"	"B"
	09	12	"D"	"C"
		13	"C"	"D"
	0A	14	00	"E"
		15	"E"	00
DF1 Layer			DLE	DLE
			ETX	ETX
			BCC	BCC

* **Note:** The data field must contain an even number of bytes with byte swapping enabled.

Chapter 9 IDP (Antenna) Commands

Chapter Objectives

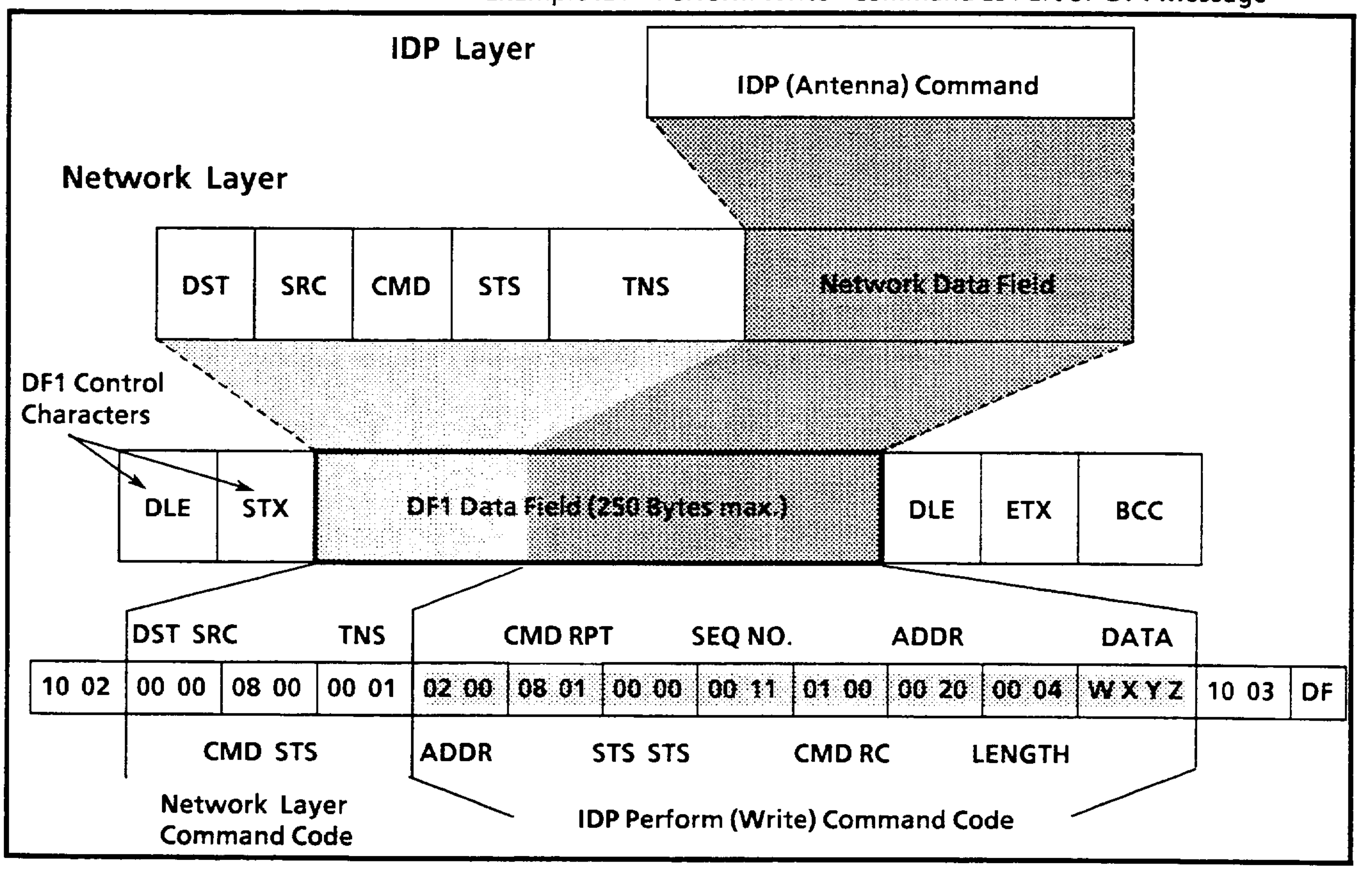
This chapter defines the commands that can be used to operate the antenna when using DF1 protocol. This chapter includes:

- General format of commands
- General format of antenna response
- Example coding, and discussion of command parameters
- Example antenna responses to commands

Applying the IDP Commands

In order to use the commands, you must insert them within the DF1 message format (see Figure 9.1). If you are using a host PLC controller, and an interface module to handle the DF1 protocol, use the command codes in this chapter with the interface module as required for system operation (see *Host Options* on page 3-1).

Figure 9.1
Example IDP "Perform Write" Command as Part of DF1 Message



General Antenna Command Format

Command information is contained in the first 8 bytes (or four words) of the IDP command. A data field follows, in some commands. Refer to the diagram and field descriptions below:

Example Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	Command	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	Sensor No. (MSB)	(06)	Sensor No. (LSB)	(07)
04	Data (if applicable)	(08)	Data (if applicable)	(09)

Command Field – Set this byte to the appropriate hex code for the desired command. See Table 9.A.

Repeat Count – Always set this byte to 00. Exception: When using the Perform command, use to set repeats of the command (see "Perform Command," page 9-20).

Sequence Number – Set this to a unique number; returned unchanged in antenna response. Use to match antenna responses with commands issued, and to manage multiple outstanding requests.

Sensor Number – Set this to 00 00.

Data Field – The data field is used in these commands:

- Echo command (Data to be echoed)
- Perform command – Hex read and/or write descriptors
- Set Interface and Sensor Configuration commands

Note: Although you can use up to 6144 data bytes in a Perform command data field, each DF1 data field, which includes both the IDP command and the network header, is limited to 250 bytes (see Figure 9.1). Any larger amount of data bytes than 250 would require you use Large Message Transfer Mode (see page 8-40).

Perform Command Descriptor Data Fields – You use the Perform command to cause the antenna to perform tag reads and writes, by using that command's data field to code read and write transaction descriptors. See "Perform Command," page 9-20, and also "Sensor Programs," page 9-21.

Transmission Modes

The antenna communicates with the host in one of two modes, "byte swapping" enabled, or disabled (see also "Byte Ordering," page 8-44). With byte swapping disabled, the antenna expects the command bytes and sends response bytes in numerical order as listed in the "Byte Offset" columns in the diagrams in this chapter.

With byte swapping enabled, the antenna expects the command bytes and sends response bytes in the opposite order of that given in the "Byte Offset" columns (i.e., 1–0, 3–2, 5–4, etc.). See page 5-8 to select the mode.

Table 9.A
Command Codes and Descriptions

Command	Code	Command Description
Echo Interface	01	This command sends data to the antenna's host interface processor; data is returned to the host unchanged. Use this command to test the communications link between host and antenna.
Echo Sensor	11	This command sends data to the antenna's sensor interface processor; data is returned to the host unchanged. Use this command to check the antenna internal RAM swapping.
Interface and Sensor Diagnostics	02	This command causes the antenna to run diagnostics on both the host interface and sensor processors. Returned results are coded in four data bytes.
Sensor Diagnostics	12	This command causes the antenna to run diagnostics on the sensor processor. Results are returned in a 2 byte data field.
Reset	03	This command causes the antenna host interface and sensor processors to reinitialize and start running again with default configuration. Host default settings listed on page 9-13. Sensor defaults to settings from the last sensor configuration command.
Get Interface Configuration	04	This command will get the current communication settings of the host interface. Configuration is returned in a 14 byte data field, and includes baud rate and other settings (listed on page 9-13).
Set Interface Configuration	05	This command sets the communication configuration of the antenna's host interface. This configuration is stored in volatile RAM. Host must configure the interface each time the antenna is reset, if settings are to be different from default settings.
Get Sensor Configuration	06	This command causes antenna to return its working parameters, such as tag type, object detect, timeout (listed on page 9-17). Some parameters (revision number and technology type) are reserved, read only.
Set Sensor Configuration	07	This command sets the antenna working parameters (listed on page 9-17). Read only fields are ignored and should be set to zero.
Perform	08	This command will cause the antenna to execute the sensor program sent to it as many times as is indicated by the repeat count. Sensor program includes read and/or write command descriptor(s).

Antenna Response Format

The antenna returns a response to each command from the host (*except* the Reset command). Response information is contained in the first 8 bytes of the antenna's IDP response.

Responses to the following commands return a data field:

- Echo (data returned).
- Perform Read (data from tag returned).
- Get Interface Configuration (configuration returned).
- Get Sensor Configuration (configuration returned).

Refer to the diagram and response field descriptions below:

Example Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	Response Code	(00)	Return Code	(01)
01	Host Interface Status	(02)	Sensor Interface Status	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	Sensor No. (MSB)	(06)	Sensor No. (LSB)	(07)
04	Data (if applicable)	(08)	Data (if applicable)	(09)

Response Code – The response returns the same command code as the antenna command code, except 80 Hex is added. For example: If the command code is 01, the response code will be 81; if the command is 12, the response code is 92, etc.

Return Code – This field contains a code indicating the success or failure status of a command execution. Table 9.B, page 9-5, lists return codes.

Host Interface Status – This field contains a code indicating host interface processor status. See Table 9.C, page 9-5.

Sensor Interface Status – This field contains a code indicating status of the sensor interface processor. Table 9.D, page 9-6, lists status codes.

Sequence Number – Unchanged (same as in command).

Sensor Number – 00 00 (same as in command).

Antenna Response Format
(continued)

Data Field – The data field is padded by the Interface Processor so that an even number of bytes are sent in response. Data is dependent on type of command. See Perform, Echo, and Get Configuration Commands for response data descriptions.

Table 9.B
Antenna Command Return Codes

Bit Set	Meaning
0	Invalid Command
1	Command execution unsuccessful
2	Command format error. See Note 2, below
3	Never returned set
4	Never returned set
5	Never returned set
6	Never returned set
7	Error (set if any other bits are set)
No bits set	Success

Note 1: More than one bit can be set.
Note 2: A command format error is returned for the following:

- "Length" in Sensor Program not equal to actual length of Data field
- Length of command header and data (if any) not as expected by antenna (header information or data lost)
- An "Enter Large Message Transfer Mode" is followed immediately by an "Exit Large Message Transfer Mode" (See pages 8-40, 8-42).

Table 9.C
Host Interface Status

Bit Set	Meaning
0	Internal interface fault
1	Host communications failure
2	Never returned set
3	Never returned set
4	Never returned set
5	Never returned set
6	Never returned set
7	Never returned set
No bits set	Normal status

Note: More than one bit can be set.

Antenna Response Format

(continued)

Table 9.D
Sensor Interface Status

Bit Set	Meaning
0	Internal sensor fault
1	Interface to sensor communications failure
2	The data buffer of the sensor has overflowed
3	Never returned set
4	Never returned set
5	Never returned set
6	Never returned set
7	Never returned set
No bits set	Normal status

Note: More than one bit can be set.

Interface Processor Echo Command

Use this command to test the communications link between the host and the antenna. You can include any ASCII characters or Hex values in the data field; the antenna response returns the data bytes unchanged.

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	01	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Data*	(08)	Data*	(09)

* Enter any number of data bytes, up to 6144 bytes

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	81	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Data (same as sent)	(08)	Data (same as sent)	(09)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Sensor Processor Echo Command

Sensor Processor Echo will take any data passed to the sensor interface and return it to the sending host unchanged. This command is used for testing the RAM swapping capability of the antenna processors.

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	11	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Data*	(06)	Data*	(07)

* Enter any number of data bytes, up to 6144 bytes

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	91	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Data (same as sent)	(08)	Data (same as sent)	(09)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Host and Sensor Interface Diagnostics Commands

Host and Sensor Interface diagnostics causes the antenna to run diagnostics on both the Host and Sensor Interface. This command requires no data field be included. Results are returned in a four byte data field.

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	02	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	91	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Host Status Code (see Table 8.E on page 8-9)	(08)	00	(09)
05	Sensor Status Code (see Table 8.F on page 8-9)	(0A)	00	(0B)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Host and Sensor Interface Diagnostics Commands
(continued)

Table 9.E
Host Interface Diagnostics Status

Bit Set	Meaning
0	RAM test failed
1	EPROM test failed
2	Always 0
3	Always 0
4	Sensor communications test failed
5	Always 0
6	Always 0
7	Always 0

Note: More than one bit can be set.

Table 9.F
Sensor Interface Diagnostics Status

Bit Set	Meaning
0	RAM test failed
1	EPROM test failed
2	EEPROM test failed
3	Decoder RAM test failed
4	Decoder ROM test failed
5	Decoder test failed
6	Always 0
7	Always 0

Note: More than one bit can be set.

Sensor Interface Diagnostics Command

Sensor interface diagnostics causes the antenna to run diagnostics on Sensor Interface. This command requires no data field. Results are returned in a two-byte data field.

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	12	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	91	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Sensor Status Code (see Table 8.F on page 8-9)	(08)	00	(09)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Antenna Reset

This command causes the Host and Sensor Interfaces to hard reset, and reinitialize.* The Host Interface Configuration will revert to default settings. See Table 9.G (page 9-13) for host interface default settings. Sensor Interface default settings will remain at the most recent Sensor Configuration Command configuration.

> ***Note:** The antenna does not return any IDP or network level response to this command. The host will only receive a DF1 level response (DLE ACK or NAK) from the antenna, indicating that the command was received by the antenna.

Command Format				
Word Offset	**Command Field**	**(Byte Offset)**	**Command Field**	**(Byte Offset)**
00	03	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

Get Interface Configuration Command

This command will get the current working parameters of the antenna's host communication interface. Parameters include baud rate, and other information (see Table 9.G, page 9-13). The configuration parameters are returned in a 14-byte data field in the antenna response (beginning with Word Offset 04 below).

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	04	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	84	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Baud rate (MSB)	(08)	Baud rate (LSB)	(09)
05	00	(0A)	00	(0B)
06	00	(0C)	00	(0D)
07	00	(0E)	00	(0F)
08	00	(10)	Transmission Options	(11)
09	Delay 0	(12)	Delay 1	(13)
0A	Revision No.	(14)	Revision Level	(15)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Note: These parameters are set and not configurable:

- 8 bits/character
- No parity
- 1 stop bit

The default baud rate depends on the baud rate dial setting (see page 5-8).

Get Interface Configuration Command
(continued)

Table 9.G
Interface Configuration Data (default settings in bold)

Byte Offset (within Data Field)	Function	Hex Value	Meaning
00 – 01 (MSB-LSB)	Set Baud Rate (see **Note** for default)	00 00	Baud rate: 300
		00 01	Baud rate: 1200
		00 02	Baud rate: 2400
		00 03	Baud rate: 4800
		00 04	Baud rate: 9600
		00 05	Baud rate: 19.2K
		00 06- FF FF	Baud rate: 9600
02 – 03	Not used	Set to 00 00	--
04 – 05	Not used	Set to 00 00	--
06 – 07	Not used	Set to 00 00	--
Byte Offset	**Function**	**Bit Value**	**Meaning**
08	Not used	Set to 00	--
09	Options		
	Bit 0 (Not used, set 0)	1	--
		0	--
	Bit 1	1	Word packed
		0	**Byte packed (default)**
	Bit 2 (Not used, set 0)	1	--
		0	--
	Bit 3	1	Link layer checksum disabled
		0	**Link Layer checksum enabled (default)**
	Bit 4	1	DF1 responses disabled
		0	**DF1 responses enabled (default)**
	Bit 5	1	Empty buffers not transmitted
		0	**Empty buffers are transmitted (default)**
	Bits 6-7 (Not used, set 0)	1	--
		0	--
Byte Offset	**Function**	**Hex Value**	**Meaning**
0A	Set Delay 0	00-FF	Delay in milliseconds before antenna sends response
0B	Set Delay 1	00-FF	Delay in milliseconds between transmission of each byte in antenna response
0C	Read only	--	Revision number
0D	Read only	--	Revision level

Note: **Default Baud rate** – dependent on dial setting (See page 5-8)
Not configurable – Bits/character: 8
– Parity: none
– Stop bits: 1

Get Interface Configuration Command
(continued)

Referring to Table 9.G, there are several parameters that can be selected for host-antenna communications that require some description. These are discussed below.

Options (byte offset 08 in Table 9.G)

Bit 1 – Word packed
Byte packed (default)

Default setting recommended. If you select word packed, the antenna is set to transmit and receive so that each command or response byte (8 bits) must be extended to a word (16 bits).

Bit 3 – Link layer checksum disabled
Link layer checksum enabled (default)

Default setting recommended, and mandatory when using a PLC and interface communication module that supplies DF1 protocol. With link layer checksum enabled, you enable the block check character (BCC) function of the DF1 protocol (see page 8-8).

Bit 4 – DF1 responses disabled
DF1 responses enabled (default)

Default setting recommended, and mandatory when using a PLC and interface communication module that supplies DF1 protocol. If you select disabled, network level responses to commands are disabled (see pages 8-3, and 8-28).

Bit 5 – Empty buffers not transmitted
Empty buffers transmitted (default)

Default setting recommended. With empty buffers transmitted, you must supply data bytes in the data field of read command descriptors in a Perform command (see "Perform Command," page 9-20, and "Sensor Programs," page 9-21).

Delay 0 (byte offset 0A in Table 9.G):

Default setting (00) is recommended. This function allows you to provide a delay in antenna response, if experience shows that a delay is required for successful host antenna communication.

Delay 1 (byte offset 0B in Table 9.G):

Default setting (00) is recommended. This function allows you to provide a delay between bytes transmitted by antenna response, if experience shows that a delay is required for successful host antenna communication.

Set Interface Configuration

This command sets the data communication options for host-antenna communications (see Table 9.G, page 9-13). Interface configuration changes take effect immediately, beginning with the response to the command that made the change.

> **Note:** The interface configuration is stored in volatile RAM. If you use settings that differ from the default settings, you must reconfigure the antenna each time the antenna is powered up or reset.

Antenna Command Format:

Command Format				
Word Offset	**Command Field**	**(Byte Offset)**	**Command Field**	**(Byte Offset)**
00	05	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Baud rate (MSB)	(08)	Baud rate (LSB)	(09)
05	00	(0A)	00	(0B)
06	00	(0C)	00	(0D)
07	00	(0E)	00	(0F)
08	00	(10)	Transmission Options	(11)
09	Delay 0	(12)	Delay 1	(13)
0A	(Read Only)	(14)	(Read Only)	(15)

Antenna Response Format:

Response Format				
Word Offset	**Response Field**	**(Byte Offset)**	**Response Field**	**(Byte Offset)**
00	85	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Get Sensor Configuration Command

Causes antenna to return its sensor interface configuration. Includes: Tag Type - Object Detect Mode - Timeout - RF Field Strength. This command has no data field. The response includes a 12 byte data field (beginning with Word Offset 04) with the configuration settings.

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	06	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

Antenna Response Format
(see Table 9.H and page 9-17 for Sensor Configuration Data)

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	86	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Reserved	(08)	Reserved	(09)
05	00	(0A)	Tag Type	(0B)
06	Firmware Revision No.	(0C)	Firmware Revision Level	(0D)
07	00	(0E)	Object Detect Enable	(0F)
08	Transaction timeout (MSB)	(10)	Transaction Timeout (LSB)	(11)
09	00	(12)	RF Field Strength	(13)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Get Sensor Configuration Command
(continued)

Table 9.H
Sensor Configuration Data for Both Get and Set Sensor Configuration

Byte Offset (within Data Field)	Function	Hex Value	Applicable Antenna Type	Meaning
00-01	Read Only/00 ①	--		Reserved (field ignored in command)
02	Not Used	00		--
03	Tag Type	00	All Antennas	6 digit, 20 or 40 character Read Only
		10	All Antennas	2K R/W
		11	All Antennas	8K R/W
		20	All Antennas	6-digit programmable
		21	All Antennas	20-character programmable
		22	All Antennas	40-character programmable
		40	All Antennas	6-digit programmable, addressable ②
		41	All Antennas	20-character programmable, addressable②
		42	All Antennas	40-character programmable, addressable ②
		60	2750-ASPF, -ASPRF	6-digit fast read
		61	2750-ASPF, -ASPRF	20-character fast read
		62	2750-ASPF, -ASPRF	40-character fast read
04	Firmware Rev.	--		(Read Only) Firmware Revision Number
05	Firmware Rev.	--		(Read Only) Firmware Revision Level
06	Not Used	00		--
07	Object Detect Mode	00		Disabled
		01		Enabled
08-09 (MSB-LSB)	Transaction Timeout	0000 - FFFF		In 100 millisecond units (setting of 00 00 disables timeout)
0A	Not Used	00		--
0B	RF Field Strength	00		Disabled
		01		Minimum ③
		02		Low ③
		03		Medium ③
		04		High ④
		05		Maximum ④

① Read only. Parameters for this field are ignored in the Set Sensor Configuration Command.
② In order to use this setting, tag memory must first be fully programmed in the corresponding programmable mode (i.e., 6-digit, or 20- or 40-character programmable mode).
③ With the 2750-ASD Antenna, setting a Hex Value of 01, 02, or 03 will all equal Low.
④ With the 2750-ASD Antenna, setting a Hex Value of 04 or 05 will both equal High.

Set Sensor Configuration Command

This command causes a sensor to start using the parameters passed in the data field. With this command, you define the antenna operation for type of tag, object detect enable, timeout, and RF field strength.

To set these parameters, you must know which of these settings is appropriate for your operation. For information regarding the RF level, object detect, and timeout settings, refer to Chapter 6.

Antenna Command Format
(see Table 9.H and page 9-17 for Sensor Configuration Data)

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	07	(00)	00	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	00	(08)	00	(09)
05	00	(0A)	Tag Type	(0B)
06	00	(0C)	00	(0D)
07	00	(0E)	Object Detect Enable	(0F)
08	Transaction timeout (MSB)	(10)	Transaction timeout (LSB)	(11)
09	00	(12)	RF Field Strength	(13)

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	87	(00)	Return Code*	(01)
01	Host Interface Status*	(02)	Sensor Interface Status*	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)

* These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.

Example Set Sensor Configuration Command

The diagram below shows the coding for a typical Set Sensor Configuration command.

According to the command in the example below, and referring to Table 9.H, the antenna would be configured for:

- 2K read/write tag (Byte Offset 0B = 10)
- Object detect mode enabled (Byte Offset 0F = 01)
- Timeout 4000 milliseconds or 4 seconds (Byte Offset 11 = 28)
- RF level set to low (Byte Offset 13 = 02)

Example Command					
Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
Command – (reserved)	00	07	(00)	00	(01)
(reserved)	01	00	(02)	00	(03)
Seq. No. (MSB-LSB)	02	12	(04)	34	(05)
Sensor No.	03	00	(06)	00	(07)
Reserved	04	00	(08)	00	(09)
Tag Type	05	00	(0A)	10	(0B)
(Read Only)	06	00	(0C)	00	(0D)
Object Detect Enable	07	00	(0E)	01	(0F)
Transaction Timeout	08	00	(10)	28	(11)
RF Field Strength	09	00	(12)	02	(13)

Perform Command

The command will cause the antenna to execute the sensor program descriptors (defined in the command data field) as many times as is indicated in the repeat count field. The results are returned to the host for each repeat of the Perform command, for each command descriptor in the Perform command data field. See also "Enable/Disable Unsolicited Response," page 8-38, for information on limiting the number of antenna responses.

Options on how the data is formatted are based on the interface configuration options. See Table 9.G, page 9-13.

Antenna Command Format:

Command Format				
Word Offset	Command Field	(Byte Offset)	Command Field	(Byte Offset)
00	08	(00)	Repeat Count ② ③	(01)
01	00	(02)	00	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Data ①	(08)	Data ①	(09)

① Up to 6144 bytes; see Sensor Programs, page 9-21.
② Repeat = 00 Repeat Perform forever with same Data field (until another command is received).
01–FF
Number of times sensor program will be repeated with same Data field.
③ Number of responses will be same as number of repeats.

Antenna Response Format:

Response Format				
Word Offset	Response Field	(Byte Offset)	Response Field	(Byte Offset)
00	88	(00)	Return Code①	(01)
01	Host Interface Status①	(02)	Sensor Interface Status①	(03)
02	Sequence No. (MSB)	(04)	Sequence No. (LSB)	(05)
03	00	(06)	00	(07)
04	Data ②	(08)	Data ②	(09)

① Several values are possible. These Hex values must be converted to binary, and decoded. Refer to Tables 9.B, 9.C, and/or 9.D (pages 9-5, 9-6) to decode.
② Responses to Sensor Program; see page 9-23.

Sensor Program

The Sensor Program defines the transaction to be performed by the antenna with the RF tags. You place the Sensor Program in the data field of the Perform command. In general, the Sensor Program consists of the read and/or write command descriptor(s), with or without data field(s).

You can chain multiple read and/or write descriptors in the Sensor Program. The number of these is limited only in that the total descriptor coding and data bytes must not exceed 6144 bytes (see "Operation" below for chaining information).

Refer to Table 8.J for coding of fields.

Command Descriptor Format				
Word Offset		(Byte Offset)		(Byte Offset)
00	Operation	(00)	00	(01)
01	00	(02)	00	(03)
02	Start Address (MSB)	(04)	Start Address (LSB)	(05)
03	Length (MSB)	(06)	Length (LSB)	(07)
04	Data①	(08)	Data	(09)
...	↓	...		...
...		...		...
...		...		...
...	Data	...	Data	...

① Data buffers optional in Read descriptors.

Command Descriptor Fields

The command descriptor fields of the Sensor Program are described below:

Operation – Set to the appropriate hex code:

Hex codes – 00 Read Command (None to follow)

01 Write Command (None to follow)

80 Read Command (More to follow)

81 Write Command (More to follow)

For a single transaction, use 00 (read) or 01 (write). To chain transactions, use 80 (read) or 81 (write). In the last descriptor in your sensor program, always use 00 (read) or 01 (write) to indicate "none to follow."

Command Descriptor Fields
(continued)

Start Address – Set the byte offset (in hex) in tag memory of the first sequential memory location to be accessed. For programming tags, set to 0, unless antenna is configured for programmable addressable tag (see "Tag Type," Table 9.H, for tag type settings). For read/write tags, first 32 bytes are reserved, read only. The start address must be an even number when antenna is set for "Byte Swapping Enabled."

Length – Set the number of bytes (in hex) to be read from or written to a tag, beginning at the Start Address (must match the number of bytes in data field). Length value (plus start address) must not exceed tag memory capacity (no. of bytes). The length must be an even number with antenna set for byte swapping enabled.

Note: The length value must match the number of bytes included in the command data field.

Data Field – The data field is used in write commands, and optionally in read commands (if empty buffers transmitted).

Data Bytes – With programmable tags, You can use a limited set of ASCII* characters, depending on the antenna configuration (see Table 7.B for descriptions of tag memory, and "Tag Type" in Table 9.H).

The number of data bytes included must match the number indicated in the Length field, or the command will fail.

***Note:** See Appendix C for ASCII conversions.

Data Buffers in a Read Descriptor – When coding a read descriptor, you can send data (ASCII 0 or space character is recommended) in the data field as a data buffer. The number of data bytes in this buffer must be the same number of bytes as the Length value. The tag data is then returned in this buffer in the response. The antenna default configuration enables this data buffer capability. You can disable this feature (see pages 9-13 to 9-15).

Sensor Program Response Fields

The fields of the Sensor Program response are described below (see also Table 9.J for response decoding):

Response Descriptor Format				
Word Offset		(Byte Offset)		(Byte Offset)
00	Operation	(00)	Result Code	(01)
01	00	(02)	Attempts	(03)
02	Start Address (MSB)	(04)	Start Address (LSB)	(05)
03	Length (MSB)	(06)	Length (LSB)	(07)
04	Data	(08)	Data	(09)
...		...		...
...		...		...
...		...		...
...	Data	...	Data	...

Operation – Returned as sent in command descriptor.

Result Code – This indicates either success (02 Hex), or the type of failure of the tag transaction.

Attempts – This indicates number of attempts made by the antenna to complete the transaction. The maximum value is 256; after this, the antenna stops counting.

Note: A consistently high number of attempts (5 or more) over several responses may indicate some kind of problem with the RF link between antenna and tags. Check component set-up, tag positioning and orientation, object detect positioning, or antenna RF level (See Chapter 10 for troubleshooting guidelines).

Start Address – Returned as sent in command descriptor.

Length – Returned as sent in command descriptor.

Data Field – The data field is returned only in read responses, if the read was successful, or if empty buffers are transmitted. The data is ASCII characters, from the RF tag.

Sensor Program Response Fields (continued)

Table 9.J
Sensor Program Descriptor Codes

Byte Offset	Function	Hex Value	Meaning
00	Operation	00	Read, no more descriptors to follow
		01	Write, no more descriptors to follow
		80	Read, more descriptors to follow
		81	Write, more descriptors to follow
01	Result Code (only in responses)	01	Operation failed. Possible causes – no tag present, tag is failing, antenna is failing, RF power is too low, or RF signal is obstructed.
		02	Operation successful.
		03	Tag detected, operation failed. Possible causes – RF power level is inadequate, RF signal is obstructed, tag is too far from antenna, or capture time is inadequate.
		09	Operation invalid, operation failed. Possible causes – tag type configuration setting is invalid for type of transaction, invalid operation code, data type not correct for tag type.
		0B	Tag detected, operation invalid, operation failed. Possible cause – antenna configured for programmable addressable tag, and tag has not been previously programmed.
02	Not Used	00	
03	Attempts (only in responses)	00 – FF	Attempts made by antenna to perform the tag transaction, until tag transaction succeeds or fails. Returned in responses only. Attempts beyond 255 (FF Hex) not counted.
04 – 05 (MSB – LSB)	Start Address	xx – xx (User Defined)	Sets the byte offset (in Hex), or address, in tag memory of the first sequential memory location to be read from or written to (must be EVEN number with byte swapping enabled).
06 – 07 (MSB – LSB)	Length	xx – xx (User Defined)	Sets the number (in hex) of successive bytes of tag memory accessed (must match number of bytes in data field, and must be EVEN number with byte swapping enabled).
08 – 09	Data	xx – xx (User Defined)	Data read from or written to the tag, or data used for buffer in tag read command (optional).

Example Perform Command

Shown below is a typical Perform Command. This command includes a tag read chained to a tag write, which would normally be used only with a read/write tag.

The command calls for the antenna to first read 4 bytes of data, starting at address 0020 Hex (32 decimal). Next the antenna writes 4 bytes of data to the tag, starting at address 0022 (34 decimal).

	Example Command Format					
	Command Field(s)	**Word Offset**		**(Byte Offset)**		**(Byte Offset)**
	Command – Repeat Ct.	**00**	08	(00)	01	(01)
	(reserved)	**01**	00	(02)	00	(03)
	Seq No. (MSB-LSB)	**02**	12	(04)	34	(05)
	Sensor No.	**03**	00	(06)	00	(07)
Start of 1st descriptor (**Read** with more to follow)	Read with more (08) Reserved (09)	**04**	80	(08)	00	(09)
	Reserved	**05**	00	(0A)	00	(0B)
	Start Addr. (MSB-LSB)	**06**	00	(0C)	20	(0D)
	Length (MSB-LSB)	**07**	00	(0E)	04	(0F)
	Data (ASCII spaces)	**08**	20	(10)	20	(11)
	Data (ASCII spaces)	**09**	20	(12)	20	(13)
Start of 2nd descriptor (**Write** with none to follow)	Write, none to follow (14) Reserved (15)	**0A**	01	(14)	00	(15)
	Reserved	**0B**	00	(16)	00	(17)
	Start Addr (MSB-LSB)	**0C**	00	(18)	22	(19)
	Length (MSB-LSB)	**0D**	00	(1A)	04	(1B)
	Data (ASCII A, B)	**0E**	41	(1C)	42	(1D)
	Data (ASCII C, D)	**0F**	43	(1E)	44	(1F)

Example Perform Response

Shown below is a typical response to the "Example Perform Command" on page 9-25. The antenna responses includes ASCII characters 1, 2, 3, and 4, which were read from the tag (see word offset 08 and 09).

	Example Response Format					
	Command Field(s)	Word Offset		(Byte Offset)		(Byte Offset)
	Command – Repeat Ct.	**00**	88	(00)	01	(01)
	Sensor – Interface STS	**01**	00	(02)	00	(03)
	Seq No. (MSB-LSB)	**02**	12	(04)	34	(05)
	Sensor No.	**03**	00	(06)	00	(07)
Start of 1st descriptor (**Read** with more to follow)	Read – Results (success)	**04**	80	(08)	02	(09)
	Attempts (5 made)	**05**	00	(0A)	05	(0B)
	Start Addr. (MSB-LSB)	**06**	00	(0C)	20	(0D)
	Length (MSB-LSB)	**07**	00	(0E)	04	(0F)
	Data (ASCII 1, 2)	**08**	31	(10)	32	(11)
	Data (ASCII 3, 4)	**09**	33	(12)	34	(13)
Start of 2nd descriptor (**Write** with none to follow)	Write – Results (success)	**0A**	01	(14)	02	(15)
	Attempts (3 made)	**0B**	00	(16)	03	(17)
	Start Addr. (MSB-LSB)	**0C**	00	(18)	22	(19)
	Length (MSB-LSB)	**0D**	00	(1A)	04	(1B)

Chapter 10 Troubleshooting

Chapter Objectives

This chapter describes maintenance and caution procedures that should be followed when using the Allen-Bradley 2750-AS series antennas. Information on defining the LED functions and a troubleshooting chart of corrective actions also appear in this chapter.

Preventive Maintenance

The antenna does not require regular maintenance. The user should periodically inspect the device to see that no metallic obstructions have settled on the antenna cover over time.

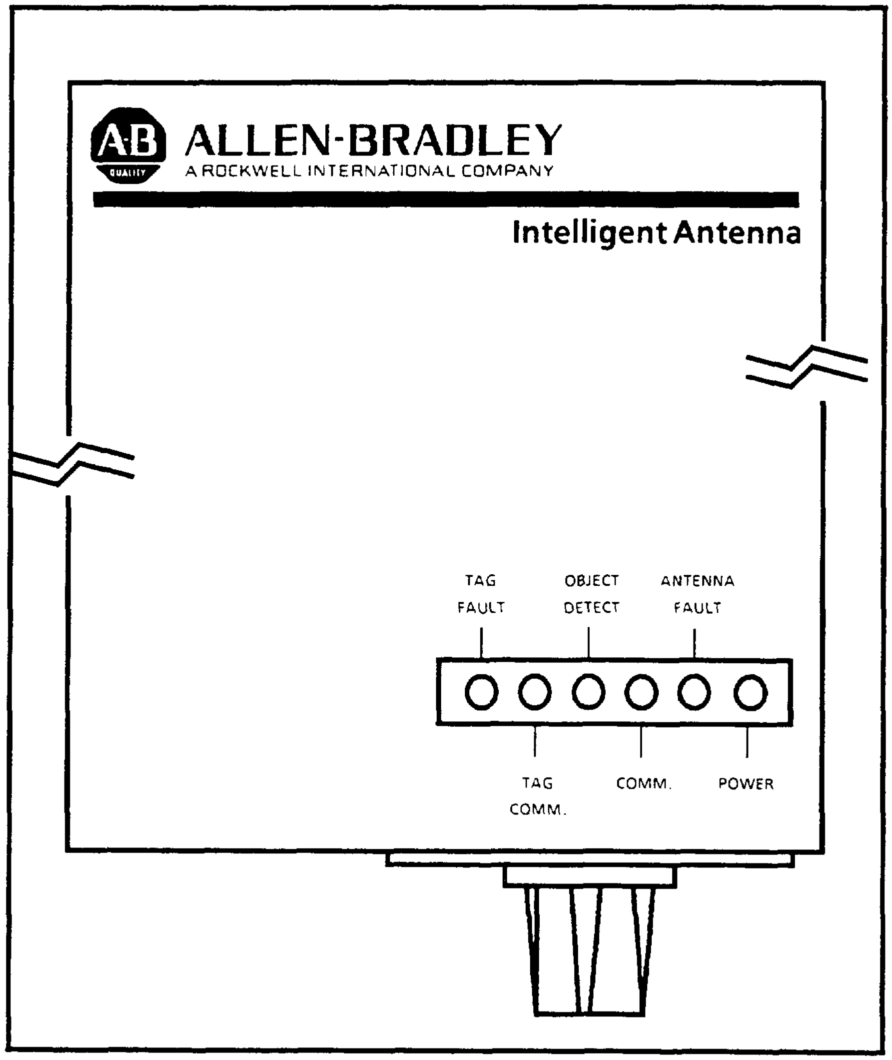
IMPORTANT: All Intelligent Antennas have a warranty seal on the base of the antenna. This consists of a white filler in one of the base plate screws. Removal of this screw and material will void the warranty.

CAUTION: Maintenance personnel carrying tags may activate unintended operations in certain antenna modes.

Diagnostic LED Indicators

Diagnostic LEDs on the device should be viewed regularly under normal operation. The LEDs are located on the face of the antenna. Figure 10.1 illustrates the face of the antenna, and the location of the LEDs.

Figure 10.1
Illustration of Antenna Face



Diagnostic LED Indicators (continued)

All the LEDs have a specified condition. Knowing the normal state will aid in troubleshooting the device if necessary.

During the antenna power-up and initialization sequence (approximately 20 seconds), the LEDs will demonstrate a patterned flashing operation.

The LEDs and their function are described in Table 10.A.

Table 10.A
LED Functions

LED Label	LED Color	Normal Status	LED Status Explanation	
			On	Off
Tag Fault	RED	Normally off.	Last read or write operation failed or timed out.	No error detected.
Tag Comm.	YELLOW	Normal status is off. Changes state as tags pass.	Data is being transferred to / from a tag.	No transmission in progress.
Object Detect	YELLOW	Normal status is off.* Changes states when O.D.closes physically or logically.	Object detect is active, or object detect mode is disabled.	Object detect is not active.
Comm.	GREEN	Normally on.	Controller communication is OK.	Controller communication is lost.
Antenna Fault	RED	Normally off.	Flashing: Intelligent Antenna fault.	Normal operations underway.
Power	GREEN	Normally on.	Power is applied.	No power applied.

* Note: If the object detect mode is disabled, this LED will always remain on.

Troubleshooting

Should the antenna not function properly the LEDs can be interpreted to indicate what corrective action should be taken. Consult Table 10.B for troubleshooting information.

Troubleshooting
(continued)

Table 10.B
Troubleshooting Guide

Condition	Corrective Actions
Power LED off. No LEDs lit.	• Check plug-in connector. • Check power supply connections. • Check power supply fuse. • Check antenna fuse. • Check other devices connected to the supply. • Replace supply. • Replace antenna.
Tag Fault LED ON/Steady	• Use Get Sensor Configuration Command and check configuration of tag type. • Use Get Sensor Configuration Command and check O.D. mode and timeout. • Try a different tag. • Check Return Codes, Sensor Status, and Interface Status in Command response. See Tables 8.B, 8.C, 8.D. • Reset antenna. • Replace the antenna.
Tag Comm. LED does not come on when tag passes	• Check power LED. • Check O.D. switch / wiring / jumper pins. • Check O.D. mode. • Check O.D. timeout. • Check antenna power level. • Replace antenna.
Object Detect status LED off when tag passes	• Check power LED. • Check wiring / jumper pins. • Check O.D. alignment. • Check O.D. configuration . • Check O.D. switch / replace. • Reset antenna. • Replace the antenna.
Comm. status off	• Check Host terminal connections. • Check wiring connections. • Check plug-in connector(s). • Check jumper pins. • Check power LED. • Check baud rate. • Reset antenna (Power OFF – Power ON). • Replace antenna.
Antenna Fault LED flashing	• Send diagnostics command and record results code included in response for interpretation • Reset device. • Reconfigure and reset. • Replace antenna.

System Fault Isolation

In order to isolate and pinpoint a system performance fault, begin by recognizing and considering the basic areas of the RFID system performance, as listed below.

Antenna Hardware:

- Antenna Power
- Antenna hardware configuration (connections and jumpers)
- Antenna LED indicators
- Connection to object detect (if used)

RFID Site:

- Signal Obstructions
- Reflective Surfaces

Host Communication:

- Host-to-antenna physical link
- Host-to-antenna message integrity

Host Message Content:

- Antenna configuration
- Antenna commands

Component Set-up:

- Tag-to-tag Spacing
- Antenna-to-tag Spacing
- Antenna-to-tag Orientation
- Object Detect connection
- Object Detect placement

Operation Definition (antenna configuration):

- Object Detect Enable
- Timeout
- Tag type
- RF level

Component Performance:

- Tag Performance
- Object Detect Performance

Defining the Problem

To begin to define a system performance problem, define the point at which system failure occurs. Depending on the nature of the problem, you can check the various basic system performance areas as appropriate. Some checks for each area are listed in the rest of this chapter (**Note**: Check first for obvious component damage or failure, for communication interruption, and RF signal obstruction).

Host Communication

Do you have communication? Check your host communication, both the physical link, and the actual communications:

Host-to-antenna physical link failure:

- Send an Echo command (see Chapter 8 or 9) to the antenna, and check the antenna Comm. LED.

  If Comm. LED doesn't go ON recheck the connections. See Chapter 5 for connecting the host to antenna, and check your host communication parameters and make sure they match the antenna.

  If Comm. LED does go ON, check the integrity of your connection or communication link.

Host to antenna communication integrity:

- Send an Echo command to the antenna, and check the data returned, and the return code (see Chapter 8 or 9).
- If the return code indicates failure, check to see the nature of the failure.

Host Message Content

If you have successful communication, check the content of your messages, and the return codes in the responses.

- Send a Get Sensor Configuration command to the antenna. Check the configuration values against those in the tables (see Chapter 8 or 9) for:
  - Tag type
  - Object Detect Mode
  - Timeout setting
  - RF level
- Send an antenna transaction (read or write) command (see Chapter 8 or 9). What results do you get? Check the return codes. Check the Tag Comm. LED.

Chapter 11 RF Tag Hardware and Installation

Chapter Objectives

Read this chapter for guidance in the installing, storing, and disposing of the Allen-Bradley Radio Frequency (RF) tags. Separate sections describe:

- Tag testing
- Tag mounting dimensions
- Tag mounting recommendations
- Tag storage recommendations
- Tag disposal requirements (for **read/write** tags only).

Chapter Overview

The Allen-Bradley RF tags operate in conjunction with the Allen-Bradley Intelligent Antennas in an RFID system (see Chapter 2 for general RFID operation information). There are two basic types of RF tags, **programmable** tags and **read/write** tags, and there are different models of each type (see Figure 11.1).

This chapter addresses the physical specifications of the two tag types for installation, storage, and handling purposes.

The tag specifications are further described in Appendix A and in Table 7.B, page 7-3. For more tag information, refer also to Publication 2750-2.9, "Product Data – Bulletin 2750 Radio Frequency Tags."

Chapter Prerequisites

The following information must be available in order to install the tags:

- Tag mounting location on item or pallet
- Tag mounting orientation

For guidelines in planning the tag mounting location and orientation, see Chapter 4.

Tag Testing

You may wish to test tag functionality prior to installing the tags. For this purpose, we recommend use of the Allen-Bradley Tag Test Stand (Catalog No. 2750-TTS). Consult your local Allen-Bradley representative for more information regarding this device.

Tag Installation Guidelines

To install the RF tag, consult with your system designer for required tag position and orientation. Tag installation recommendations differ, depending on the type of tag.

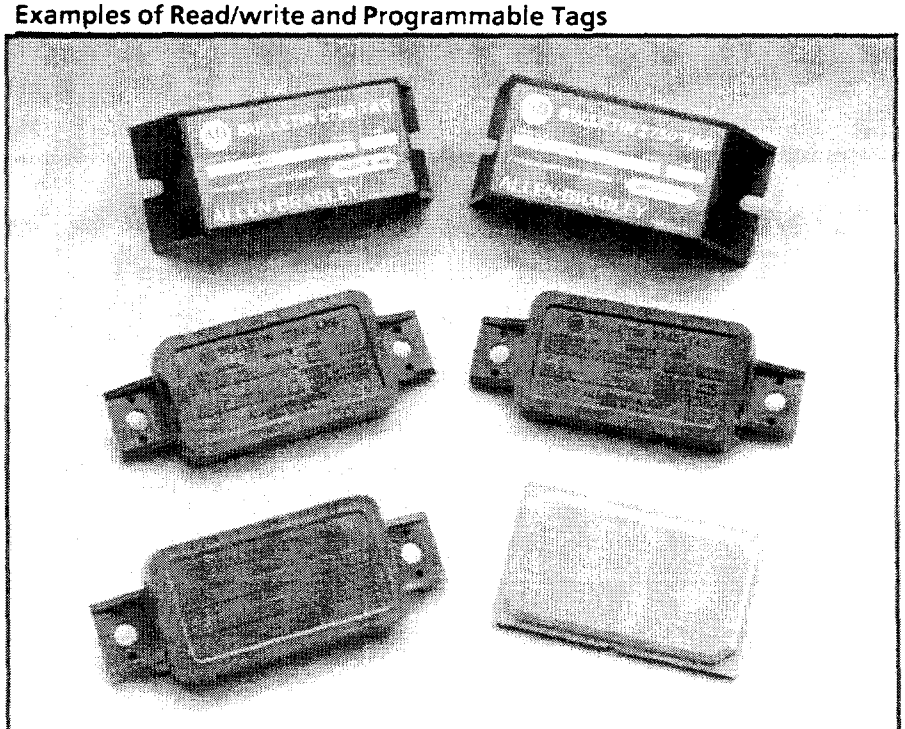
Refer to the guidelines in this section for each tag type. Refer to Figures 11.2, 11.3, and 11.4 for tag dimensions.

Programmable Tags

For mounting the programmable tags other than the Flatpak tags, follow these guidelines (see Figure 11.2):

- Use of non-metal screws (nylon) is suggested.
- Screw size: Up to $\frac{1}{4}$ – 20
- Use only non-metal flat washers
- Torque to 10 inch/pounds maximum to avoid breakage.

Figure 11.1
Examples of Read/write and Programmable Tags



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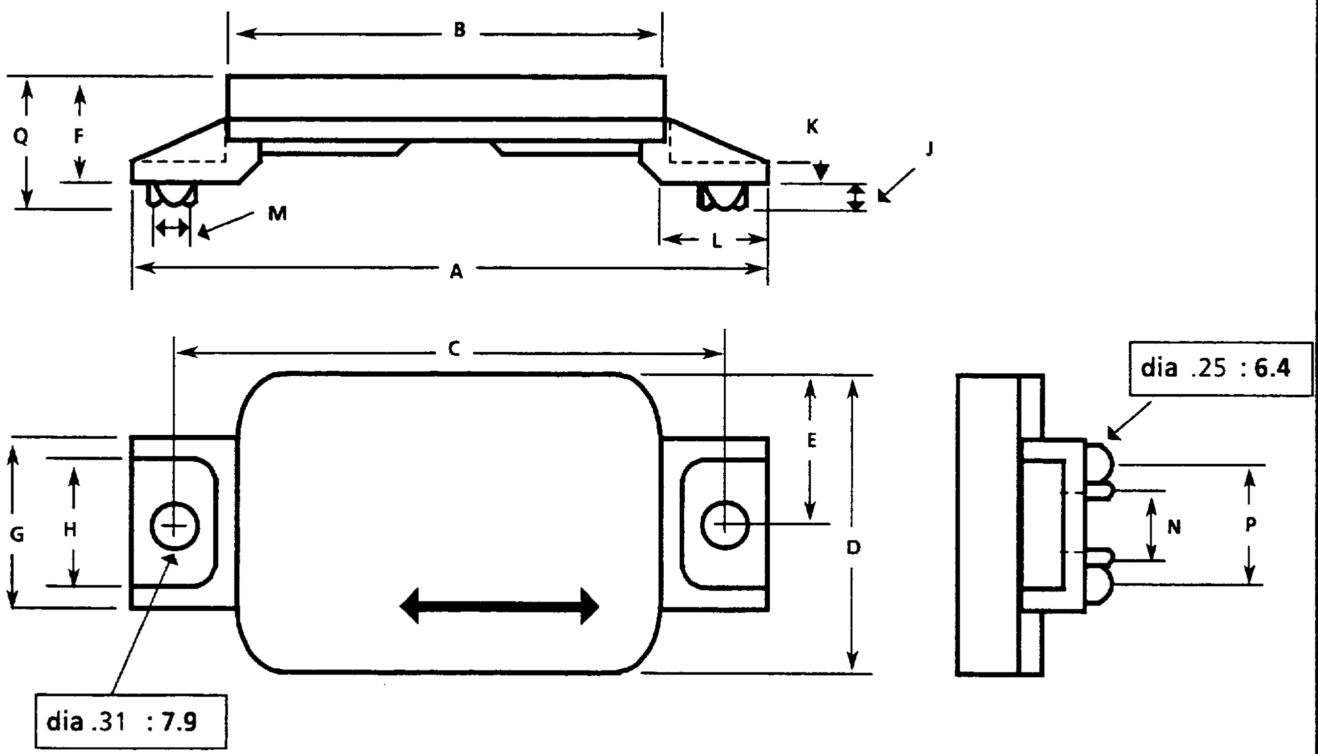
Programmable Tags
(continued)

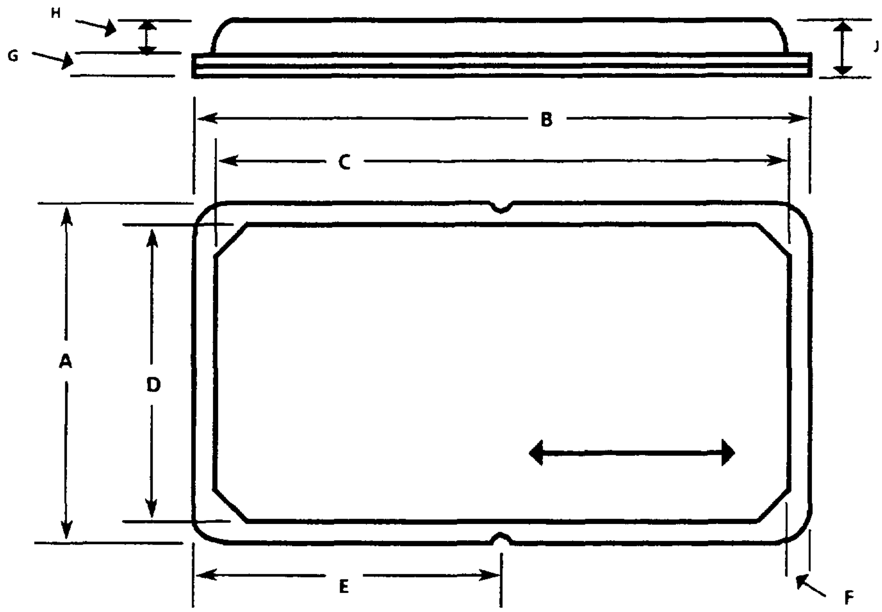
Figure 11.2
Mounting Dimensions, Programmable Tags, Including Catalog Nos. 2750-TAU40 and -TSHU40

Dimensions	inches	mm	Dimensions (cont.'d)	inches	mm	Dimensions (cont.'d)	inches	mm
A	5.2	132	F	.82	20.8	L	.82	20.8
B	3.37	85.6	G	1.1	28	M	.22	5.6
C	4.43	113	H	.85	21.6	N	.37	9.4
D	2.03	51.6	J	.22	5.6	P	.72	18.3
E	1.02	25.9	K	.13	3.3	Q	1.04	26.4



Programmable Tags
(continued)

Figure 11.3
Mounting Dimensions, Flatpak tag, Catalog No. 2750-TFAU40



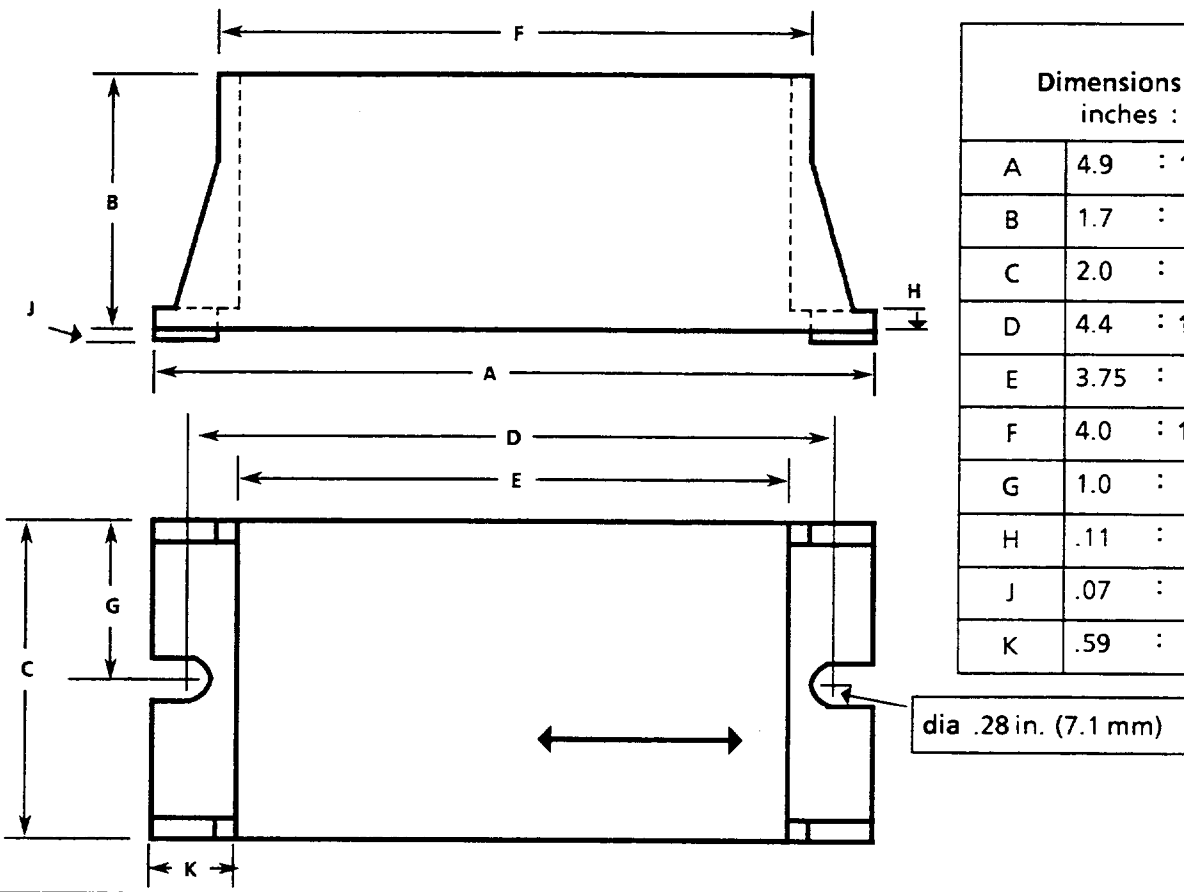
Dimensions	inches : mm
A	2.15 : **54.6**
B	3.7 : **93.9**
C	3.45 : **87.6**
D	1.9 : **48.2**
E	1.85 : **47.0**
F	.12 : **3.1**
G	.17 : **4.3**
H	.18 : **4.6**
J	.35 : **8.9**

Read Write Tags

For mounting read/write tags (see Figure 11.4):

- Screw size: Up to 10/32
- Use of flat washers with screws is recommended.
- Torque to 20 inch/pounds maximum to avoid breakage.

Figure 11.4
Mounting Dimensions, Read/WriteTags, Catalog Nos. 2750-TFAW2K and -TFAW8K



Dimensions	inches	mm
A	4.9	124.4
B	1.7	43.2
C	2.0	51
D	4.4	111.8
E	3.75	95.3
F	4.0	101.6
G	1.0	25.4
H	.11	2.8
J	.07	1.8
K	.59	15.0

Tag Mounting

For best results, mount RF tags flush on a smooth metallic backplane surface.* Non-metal backplane may result in higher signal power setting requirement. Recommended minimum backplane dimension is 8 inches × 8 inches (20 × 20 cm), although the width can be reduced to 2 inches or less.

* **Note:** The Flatpak tag, Catalog No. 2750-TFAU40, is an exception to this. The Flatpak tag is designed for mounting to a non-metallic surface only.

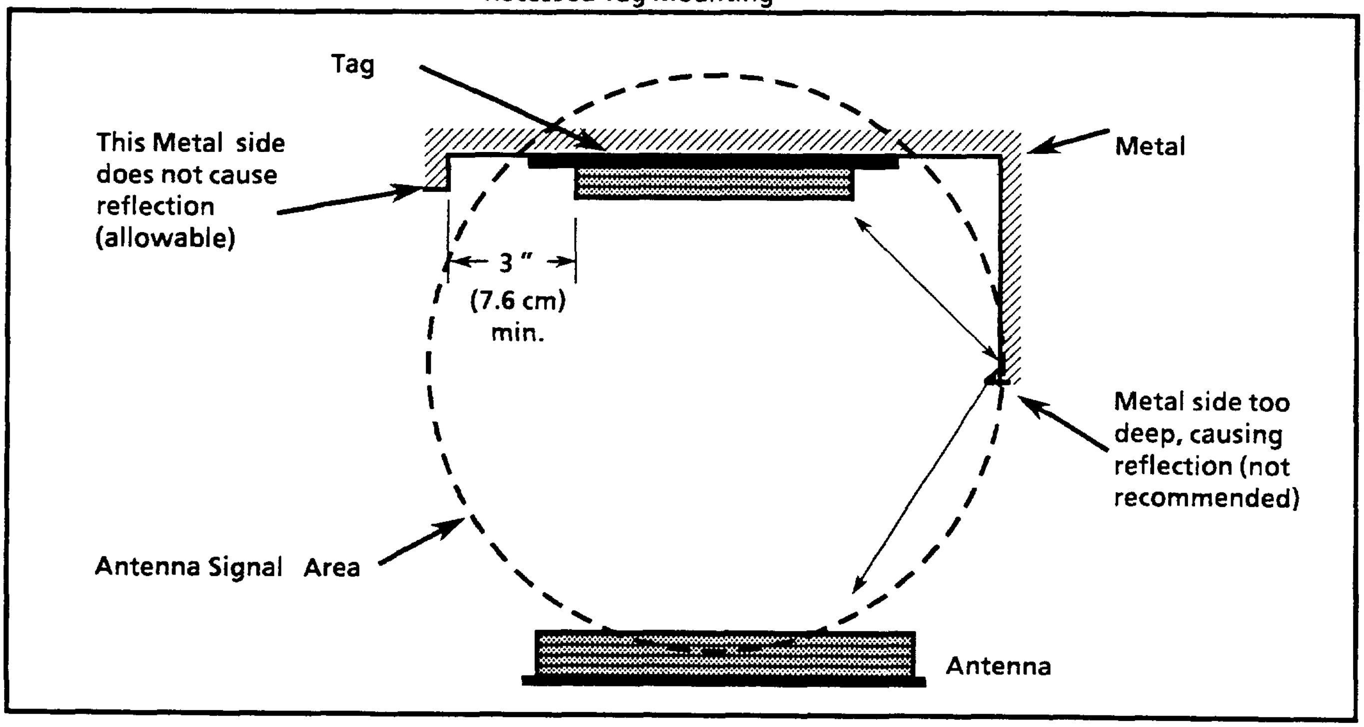
Consult factory about use of backplanes shorter than 8 inches or narrower than 2 inches.

Recessed Tag Mounting

If you plan to mount the RF tags within a recessed metal cavity, consult your Allen-Bradley representative for application specific guidelines to obtain the best results. General guidelines are (see Figure 11.5):

- Always allow a **minimum** of 3 inches (7.6 cm) spacing between sides of the tag and the cavity walls.
- If the cavity walls extend beyond the top of the tag, the spacing between the wall and tag should be great enough so the wall does not reflect the RF signals and interfere with antenna/tag transactions (consult Allen-Bradley for specific recommendations).

Figure 11.5
Recessed Tag Mounting



Tag Storage

Store tags that are not in use in an area well outside the active antenna range, preferably behind the antenna face. See Chapter 4, Table 4.A and Figure 4-3 for details.

We recommend storing tags in a completely shielded (no openings) metal enclosure whenever tags must be stored closer than the recommended distance from an active antenna. This is particularly important for Read-Write tags as battery life can be reduced if a nearby antenna can constantly trigger them "ON".

Data in Programmable tags can also be changed if they are stored too close to an active tag programming station.

Tag Disposal

The Allen-Bradley read/write tags, including Catalog Nos. 2750-TFAW2K and -TFAW8K, contain lithium batteries. Consult local Environmental Agencies for proper disposal procedures for lithium batteries.

WARNING: Read/Write tags, Catalog Nos. 2750-TFAW2K and 2750-TFAW8K, contain lithium batteries. The lithium battery information provided here must be followed. If you fail to do so, equipment could be damaged and/or personnel could be injured.

Do not incinerate or dispose of lithium batteries in general trash collection. Explosion or rupture is possible.

Lithium can cause burns to skin. Do not pick up a ruptured tag with bare hands. Use tongs, a scoop, or a shovel.

Do not use water or carbon dioxide (CO_2) fire extinguishers on fires that contain lithium batteries. Lithium is reactive with these substances.

Appendix A Specifications

Antenna

(Catalog Nos. 2750-AS, -ASD, -ASP, -ASPF, -ASPR, -ASPRF)

Electrical:	
Input Power	Transformer (Cat. No. 2750-PA). 24 VAC (+20%, –25%) @ 2 Amps.
Connectors	2 Pressure plate type screws (8- and 5-terminal)
Object Detect Switch:	
Supply Source	10VDC to 30VDC at 50 ma. (Bul. 880L Recommended).
Sink/Source Current	8-25ma.
Mechanical:	
Enclosure:	
Rating	NEMA Type 4, 12, 13
Material	Main body: Die cast aluminum Remote head: Plastic.
Dimensions, Main Body:	
Length	13.5 in. (34.3 cm)
Width	7.8 in. (19.6 cm)
Height	4.37 in. (11.1 cm)
Weight	14.0 lbs (6.4 kg)
Remote Antenna Head:	
Length	5.12 in. (13.0 cm)
Width	4.1 in. (10.5 cm)
Height	1.25 in. (3.2 cm)
Weight	0.75 lbs (0.34 kg)
Cable Requirements:	
Remote head connection (for 2750-ASD, -ASPR, -ASPRF only)	2 Coaxial Cables (Cat. No. 2750-C1)
Serial communication:	
RS-232	Shielded, 50 ft. max. to host port
RS-422	Shielded, 2000 ft. max. to host port
Communications:	
Serial formats	RS-232, RS-422
Protocol	Simple ASCII or DF1/IDP
Environmental:	
Operating Temperature	0°C to +60°C.
Storage Temperature	–40°C to +85°C.
Relative Humidity	5 to 95%, non-condensing.
Capabilities:	
Power Levels	Catalog Nos. 2750-AS, -ASP, -ASPF -ASPR, -ASPRF: Programmable - 5 Steps (Minimum, Low, Medium, High & Maximum). Catalog No. 2750-ASD: Programmable - 2 Steps (Low, High).
Read / Write Data Transfer	6,144 bytes maximum transfer capability.
Intelligent Antenna Configuration	Software selected and stored in EEPROM.
Tag Types	Read / Write –2K, 8K bytes. Programmable – 6-digit, 20- character and 40-character

Antenna *(continued)*

Approvals:	The 2750-AS, -ASD approved under FCC Regulations Part 15, Subpart F. FCC ID: FUN4TM2700, FUN4TM2750-D **The 2750-ASP, -ASPF, -ASPR, -ASPRF require an FCC approved site license for operation of the antenna in the United States.**

Programmable Tag *(Catalog Nos. 2750-TPC20, -TSHU40, -TFAU40, -TAU40 - Series A & B)*

Passive Programmable 6 digit, 20, or 40 Character Format Tags.
(For more information, see Publication No. 2750-2.9, "Bulletin 2750 RF Tags")

Electrical:	
Input Power	EEPROM memory. No battery required.
Mechanical:	
Enclosure Material: Rating	Plastic – Watertight and submersible. NEMA Type 4, 6P, 12, 13. (Catalog Nos. 2750-TAU40 and -TFAU40 are NEMA 4 only.)
Approx. Dimensions:	See pages 11-3 and 11-4.
Approx. Weight	2.5 oz. (70 gms.).
Mounting Orientation:	With -AS, -ASP, -ASPF Antenna Pitch ± 0° Roll ± 25° Yaw 360° With -ASD, -ASPR, -ASPRF Antenna Pitch ± 0° Roll ± 25° Yaw ± 25°
Environmental:	
Operating Temperature	0°C to +70°C.
Storage Temperature	–40°C to +85°C.
Maximum Operating Temperature	Excursion to 200° C for 30 min. non-operative, operations resume after the tag cools to +70° C (2750-TSHU40 or -TPC20 only).
Data Retention	10 years below +70°C. 300 hours @ +200°C.
Capabilities:	
Operating Frequency	915 / 1830 MHz.
Memory	40 bytes total: 6, 20, and 40 byte formats are available.

Programmable Tag (Catalog Nos. 2750-TPC20, -TSHU40, -TFAU40, -TAU40 - Series A & B) (continued)

Read Distance

Antenna Type 2750-	Distance from Antenna
AS, ASP, & ASPF	6 – 48 inches (15 – 122 cm)
ASPR, & ASPRF	6 – 60 inches (15 – 152 cm)
ASD - low power - high power	 2 – 4 inches (5 – 10 cm) 2 – 8 inches (5 – 20 cm)

Programming Distance

Antenna Type 2750-	Distance from Antenna
ASP & ASPF	5 – 7 inches (13 – 18 cm)
ASPR, & ASPRF	5 – 9 inches (13 – 23 cm)
AS & ASD	cannot program tags

Programmable Tag (Catalog Nos. 2750-TPC20, -TSHU40, -TFAU40, -TAU40 - Series A only)

Tag Speed –

	Antenna Type 2750-	Distance from Antenna
Program	ASP & ASPR	stationary
Read	AS & ASP	880 ft./min./40 characters at 4 feet (268 m./min./40 characters at 1.2m.)
	ASPF	1320 ft./min.at 3 feet (402 m./min./40 characters at .91 m.)
	ASD	15 ft./min./40 characters at 2 inches (4.57 m./min./ 40 characters at 5 cm.) 20 ft./min./40 characters at 8 inches (6.1 m./min./ 40 characters at 20 cm.)
	ASPR& ASPRF	1100 ft./min./40 characters at 5 feet (335 m./min./40 characters at 1.52m.)

Programmable Tag "Fast Read" 2750-TAU40 Series B only

Tag Speed –

	Antenna Type 2750-	Distance from Antenna
Program	ASPF & ASPRF	stationary
Read	ASPF	**6 character** –100 miles/hr. at 3 feet (161 km./hr at .91 m.) **20 character** – 50miles/hr. at 3 feet (121 km./hr at .91 m.) **40 character** – 25miles/hr. at 3 feet (56 km./hr at .91 m.)
	ASPRF	**6 character** –100 miles/hr. at 3.5 feet (161 km./hr at 1.07 m.) **20 character** – 55miles/hr. at 3.5 feet (121 km./hr at 1.07 m.) **40 character** – 30miles/hr. at 3.5 feet (56 km./hr at 1.07 m.)

Read/Write Tag (Catalog Nos. 2750-TFAW2K, -TFAW8K)

Industrial Read / Write Tags (2K or 8K Bytes)
(For more information, see Publication No. 2750-2.9, "Bulletin 2750 RF Tags")

Electrical:

Input Power	Battery powered device.

Mechanical:

Enclosure:	
Rating	NEMA Type 4, 12.
Dimensions:	See page 11-5.
Approx. Weight	5.5 oz. (154 gms.).
Mounting:	With -ASD, -ASPR, -ASPRF Antenna:
Orientation	Pitch ± 0° Roll ± 25° Yaw ± 25°
	Note: Tag may be off axis in one direction only.

Environmental:	Clean with standard industrial solvent (not MEK, TOLUENE, FREON etc.)
Operating Temperature	0°C to +50°C.
Storage Temperature	- 40°C to +70°C.
Tag Life	5 year battery shelf life (also depends on number of read / write cycles).

Capabilities:

Operating Frequency	915 / 1830 MHz.
Memory	2K or 8K bytes of RAM

Read or Write Distance

Antenna Type 2750-	Distance from Antenna
AS, ASP, & ASPF	6 – 24 inches (15 – 61 cm)
ASPR, & ASPRF	6 – 48 inches (15 – 122 cm)
ASD - low power - high power	 2 – 4 inches (5 – 10 cm) 2 – 8 inches (5 – 20 cm)

Tag Speed – Read or Write

Antenna Type 2750-	Distance from Antenna
AS	300 ft./min./32 bytes at 2 ft. (91.4 m/min./32 bytes at 61 cm)
ASP	880 ft./min./32 bytes at 2 ft. (268 m/min./32 bytes at 61 cm)
ASPR	1760 ft./min./32 bytes at 4 ft. (536 m/min./32 bytes at 122 cm)
ASD	100 ft./min./32 bytes at 2 in. (30.5 m/min./32 bytes at 5 cm) 130 ft./min./32 bytes at 8 in. (39.6 m/min./32 bytes at 10 cm)
ASPF	45 miles/hr./32 bytes at 3 ft. (72.4 km/hr./32 bytes at .91 m)
ASPRF	55 miles/hr./32 bytes at 3.5 ft. (88.5 km./hr./32 bytes at 1.07 m)

Power Supply
(Catalog No. 2750-PA)

Electrical:

Dual Primary	97–128 VAC, 47–63 Hz. 195–253 VAC, 47–63 Hz.
Secondary	24 VAC.
Regulation	±10%.
Load Current	10Amp.
Isolation	2500V. primary to secondary.
Overload Protection	Fused secondary.
Input Connections	The 97–128 VAC input will be formed when H1 and H3 are connected together, and H2 and H4 are connected together. The line voltage is then applied to (H1, H3) and (H2, H4). The 195–253 VAC input will be formed when H2 and H3 are connected together and line voltage is applied to H1, H4.

Mechanical:

Approx. Dimensions	
Length	6.0 in. (15.2 cm.)
Width	4.5 in. (11.4 cm.)
Height	5.3 in. (13.3 cm.) Height includes the terminal block.

Environmental:

Operating Temperature	0°C to +60°C.
Output (Secondary) Terminals	There are 4 sets of output connections for the 2750-PA, labeled X1 & X2.
Wire Size	14 gauge
Fuse Type	Littelfuse 3 AB "SloBlo" Catalog No.325010
Rating	10 Amps.

Appendix B Calculating the BCC

Appendix Objectives

This appendix describes calculating the block check character (BCC), which you can use when you program DF1/IDP protocol. Using the BCC helps verify that the data contained in a DF1 message data field is intact. In order to use the BCC, you would 1) create a BCC and append it to the end of the DF1 transmission, and 2) calculate a BCC based on the incoming DF1 message data field, and compare to the corresponding BCC appended to the incoming message. See "Block Check Character" on page 7-8

Calculate the twos complement BCC value as follows:

1. Add all the hexadecimal values in the DF1 data field, and discard any overflow (if the sum requires more than eight bits, use only the eight least significant bits).

   (**Note:** Do not include embedded responses, if any [**DLE ACK** or **DLE NAK**]. If a value of 10 Hex is used twice in succession, only the first is counted. See "Data Field" on page 7-6.

2. Convert the hexadecimal sum in step 1 to an equivalent eight-bit binary code.

3. Change the eight-bit binary value in step 2 to its twos complement as follows:

   a. Change each zero bit to a one, and each one to a zero.

   b. Add one to the eight-bit value in step 3.a. The result is the twos complement value required for the **BCC**.

Example Block Check Calculation – Assume a DF1 data field contains the data codes 08, 09, 06, 00, 02, 04, and 03. The DF1 message coding would be:

DLE	STX	(Data)	DLE	ETX	BCC
(10)	(02)	08 09 06 00 02 04 03	(10)	(03)	(??)

Appendix Objectives
(continued)

Adding the data bytes 08, 09, 06, 00, 02, 04, and 03, the sum is 20 hex. To calculate **BCC**, convert 20 Hex to binary, and:

0010 0000	←	20 hex – converted to binary
↓ ↓ ↓ ↓ ↓ ↓	←	(complement the bits)
1101 1111	←	complemented binary value
+ 1	←	add 1 (binary addition)
1110 0000	←	2's complement. Convert to Hex = **E0 Hex**

The **BCC** value is **EO**.

Appendix C ASCII Conversion Table

ASCII or Control Char.	Decimal Value	Hex Value	ASCII or Control Char.	Decimal Value	Hex Value	ASCII or Control Char.	Decimal Value	Hex Value	ASCII or Control Char.	Decimal Value	Hex Value
NUL	0	0	[Space]	32	20	@	64	40	`	96	60
SOH	1	1	!	33	21	A	65	41	a	97	61
STX	2	2	"	34	22	B	66	42	b	98	62
ETX	3	3	#	35	23	C	67	43	c	99	63
EOT	4	4	$	36	24	D	68	44	d	100	64
ENQ	5	5	%	37	25	E	69	45	e	101	65
ACK	6	6	&	38	26	F	70	46	f	102	66
BEL	7	7	'	39	27	G	71	47	g	103	67
BS	8	8	(	40	28	H	72	48	h	104	68
HT	9	9	)	41	29	I	73	49	i	105	69
LF	10	A	*	42	2A	J	74	4A	j	106	6A
VT	11	B	+	43	2B	K	75	4B	k	107	6B
FF	12	C	,	44	2C	L	76	4C	l	108	6C
CR	13	D	-	45	2D	M	77	4D	m	109	6D
SO	14	E	.	46	2E	N	78	4E	n	110	6E
SI	15	F	/	47	2F	O	79	4F	o	111	6F
DLE	16	10	0	48	30	P	80	50	p	112	70
DC1	17	11	1	49	31	Q	81	51	q	113	71
DC2	18	12	2	50	32	R	82	52	r	114	72
DC3	19	13	3	51	33	S	83	53	s	115	73
DC4	20	14	4	52	34	T	84	54	t	116	74
NAK	21	15	5	53	35	U	85	55	u	117	75
SYN	22	16	6	54	36	V	86	56	v	118	76
ETB	23	17	7	55	37	W	87	57	w	119	77
CAN	24	18	8	56	38	X	88	58	x	120	78
EM	25	19	9	57	39	Y	89	59	y	121	79
SUB	26	1A	:	58	3A	Z	90	5A	z	122	7A
ESC	27	1B	;	59	3B	[	91	5B	{	123	7B
FS	28	1C	<	60	3C	\	92	5C	|	124	7C
GS	29	1D	=	61	3D	]	93	5D	}	125	7D
RS	30	1E	>	62	3E	^	94	5E	~	126	7E
US	31	1F	?	63	3F	_	95	5F			

Appendix D Considerations for Use in the United States

FCC Licensing Requirements

Operation of the Allen-Bradley 2750-AS series antennas in the United States falls under the regulation of the Federal Communications Commission (FCC).

FCC site licensing is necessary to operate the 2750-ASP, -ASPR, -ASPF and -ASPRF serial antennas. Call your local Allen-Bradley representative for assistance in the procedure of applying for site licensing. The FCC approval or license requirement for each of the different serial antenna types is listed below:

Catalog No. 2750-AS – is FCC approved.* FCC site license is **not required** by the user to operate this device.

FCC ID: FUN4TM2700

* This device is approved under FCC Regulations Part 15, Subpart F.

Catalog No. 2750-ASD – is FCC approved.* FCC site license is **not required** to operate this device.

FCC ID: FUN4TM2750-D

* This device is approved under FCC Regulations Part 15, Subpart F.

Catalog No. 2750-ASPR, -ASPRF – FCC approved site **license is required** for operation of the antenna.

Catalog No. 2750-ASP, -ASPF – FCC approved site **license is required** for operation of the antenna.

ANSI Safety Level Standards

Non-Ionizing Radiation

The user is referred to ANSI C95.1-1982, **Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300 KHz to 100 GHz.** The ANSI C95.1-1982 standard does not consider products with 7 watts or less into the radiated element, at frequencies between 300 KHz and 1 GHz, to be a health hazard.

The Bulletin 2750-AS, ASP, ASPR and ASD outputs are within ANSI standard for safety levels with respect to human exposure to RF electromagnetic fields.

RF Tag Disposal

The Allen-Bradley read/write tags contain lithium batteries.

Tags with lithium batteries must be packaged and shipped, in accordance with transportation regulations, to a proper disposal site. The U.S. Department of Transportation authorizes shipment of "lithium batteries for disposal" by motor vehicle only in regulation 173.1015 of CFR49 (effective Jan. 5, 1983). For additional detailed information, contact:

U.S. Department of Transportation
Research and Special Programs Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Although the United States Environmental Protection Agency at this time has no regulations specific to lithium batteries, the material contained in the battery may be considered toxic, reactive, or corrosive. The person disposing of the material is responsible for any hazard created in doing so. State and local regulations may exist regarding the disposal of these materials.

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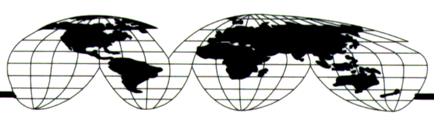
Topic *Page*

Rockwell Automation

Rockwell Automation helps its customers receive a superior return on their investment by bringing together leading brands in industrial automation, creating a broad spectrum of easy-to-integrate products. These are supported by local technical resources available worldwide, a global network of system solutions providers, and the advanced technology resources of Rockwell.



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Rockwell Automation Headquarters, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414 382-2000 Fax: (1) 414 382-4444
Rockwell Automation European Headquarters, Avenue Hermann Debroux, 46, 1160 Brussels, Belgium, Tel: (32) 2 663 06 00, Fax: (32) 2 663 06 40
Rockwell Automation Asia Pacific Headquarters, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846
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